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# INTERIM REPORT

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## FOR BIOVENTING

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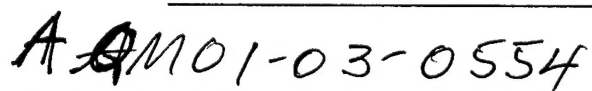
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#### ROBINS AIR FORCE

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##### BASE, GEORGIA

January 13, 1993



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**INTERIM REPORT**  
**January 13, 1993**

**FOR**

**BIOVENTING FIELD INITIATIVE**

**AT**

**ROBINS AIR FORCE BASE, GEORGIA**

**to**

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**INTERIM REPORT**  
**FOR**  
**BIOVENTING FIELD INITIATIVE**  
**AT**  
**ROBINS AIR FORCE BASE, GEORGIA**

**1.0 INTRODUCTION**

This report describes the activities conducted at three sites at Robins Air Force Base (AFB), Georgia, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE). This report summarizes the results from the first phase of the study, which includes a soil gas survey, air permeability test, in situ respiration tests, and installation of bioventing systems. The specific objectives of this task are described in the following section.

**1.1 Objectives**

The purpose of these field test methods is to measure the soil gas permeability and microbial activity at three contaminated sites and to evaluate the potential application of the bioventing technology to remediate the sites. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system at each site. Soil gas from the candidate sites should exhibit relatively high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location will also be identified.
- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined for each site. This will require air to be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.
- Immediately following the soil gas permeability test, an in situ respiration test will be conducted at each site. Air will be injected into selected monitoring points to

aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

- Using the data from the soil gas permeability and in situ respiration tests, an air injection/withdrawal rate will be determined for use in the bioventing test at each site. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

## **1.2 Site Description**

Robins AFB is located approximately 10 miles south of Macon, Georgia, adjacent to the town of Warner Robins, Georgia. Summaries of the descriptions of each site are presented in the following sections.

### **1.2.1 Site 272**

Site 272 consisted of a 250-gallon diesel tank abandoned in place approximately 10 years ago. The tank was removed in October 1989. Soil sampling performed after tank removal indicated TPH concentrations in excess of 2,000 ppm in some locations. Soil boring logs were not available for the site, but based on observations during tank removal, the site geology is probably similar to that of Site UST 173 (Section 1.2.2). A schematic diagram of Site 272 is shown in Figure 1. No monitoring wells were present at this site; however, based upon general knowledge of groundwater it was estimated that the depth to water was approximately 30 feet.

### **1.2.2 Site UST 173**

Site UST 173 had a 1,500-gallon diesel tank next to Building 173 on the base that was abandoned in place approximately 20 years ago. The tank was removed in October 1989. Site investigation activities conducted subsequent to the tank removal indicated residual soil contamination. The site was re-excavated, and approximately 200 cubic yards of soil were removed for disposal. Soil contamination remained on the southern boundaries of the excavation, but could not be removed without undermining the foundation of a gazebo on site. Soil samples taken from the south wall of

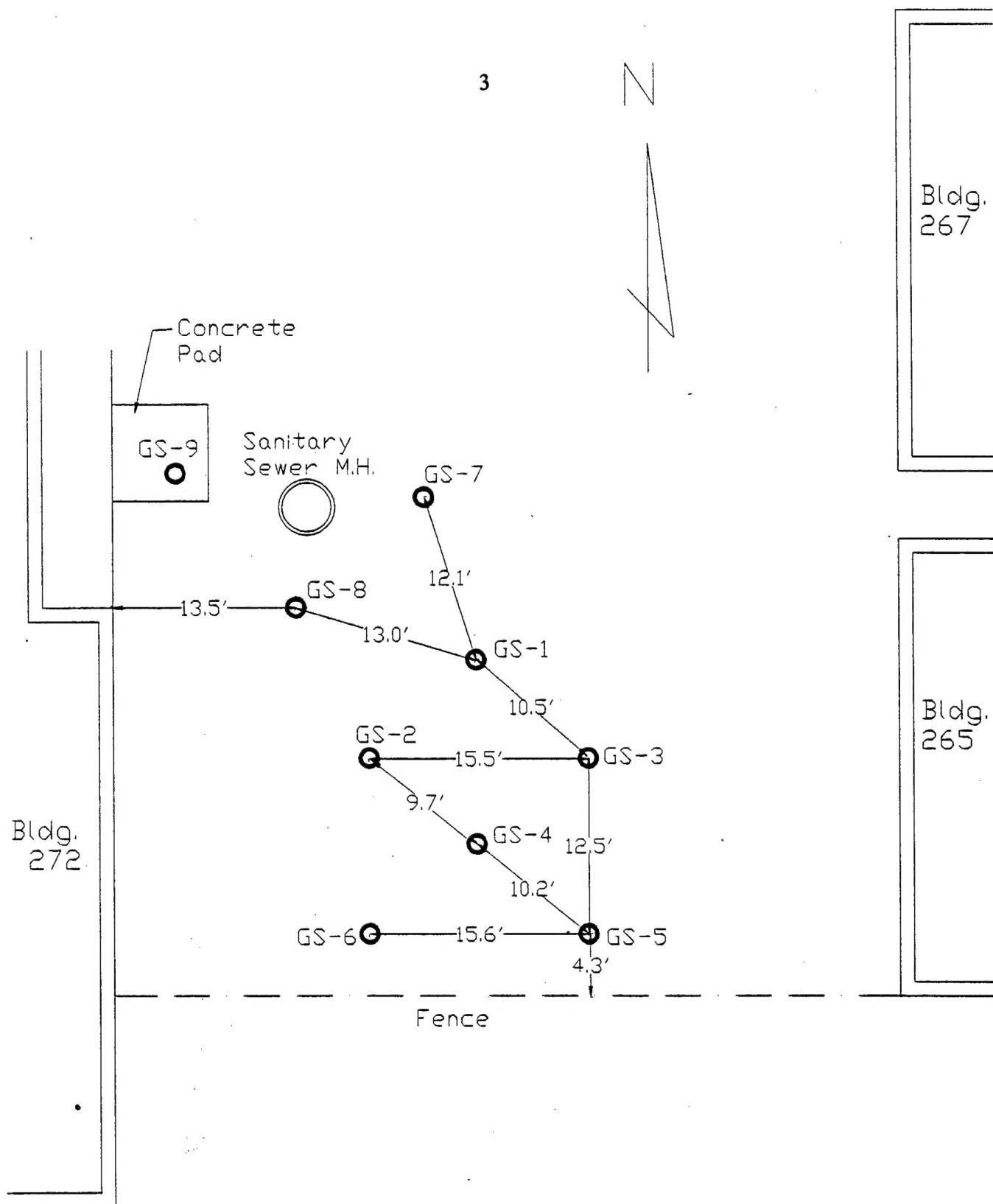


Figure 1. Schematic Diagram of Site 272 at Robins AFB

the excavation pit exhibited TPH concentrations as high as 22,600 ppm. Elevated concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) also were detected. Figure 2 is a schematic diagram of Site UST 173. Soil borings taken at the site during the site investigation show dense, clayey sand to a depth of approximately 5 feet; coarse sand and gravel to approximately 25 feet; and stiff, tannish white clay below 25 feet. All borings were terminated in the stiff clay, and no groundwater was encountered. No monitoring wells were present at this site; however, based upon general knowledge of groundwater it was estimated that the depth to water was approximately 30 feet.

### 1.2.3 Site SS-10

Site SS-10 is located adjacent to a JP-4 jet fuel storage tank farm. Monitoring wells were present on this site, and depth to water ranged from 5 to 19 feet. Free product has been encountered floating on the shallow groundwater, and elevated petroleum hydrocarbon concentrations have been detected in site soils. Figure 3 is a schematic diagram of Site SS-10.

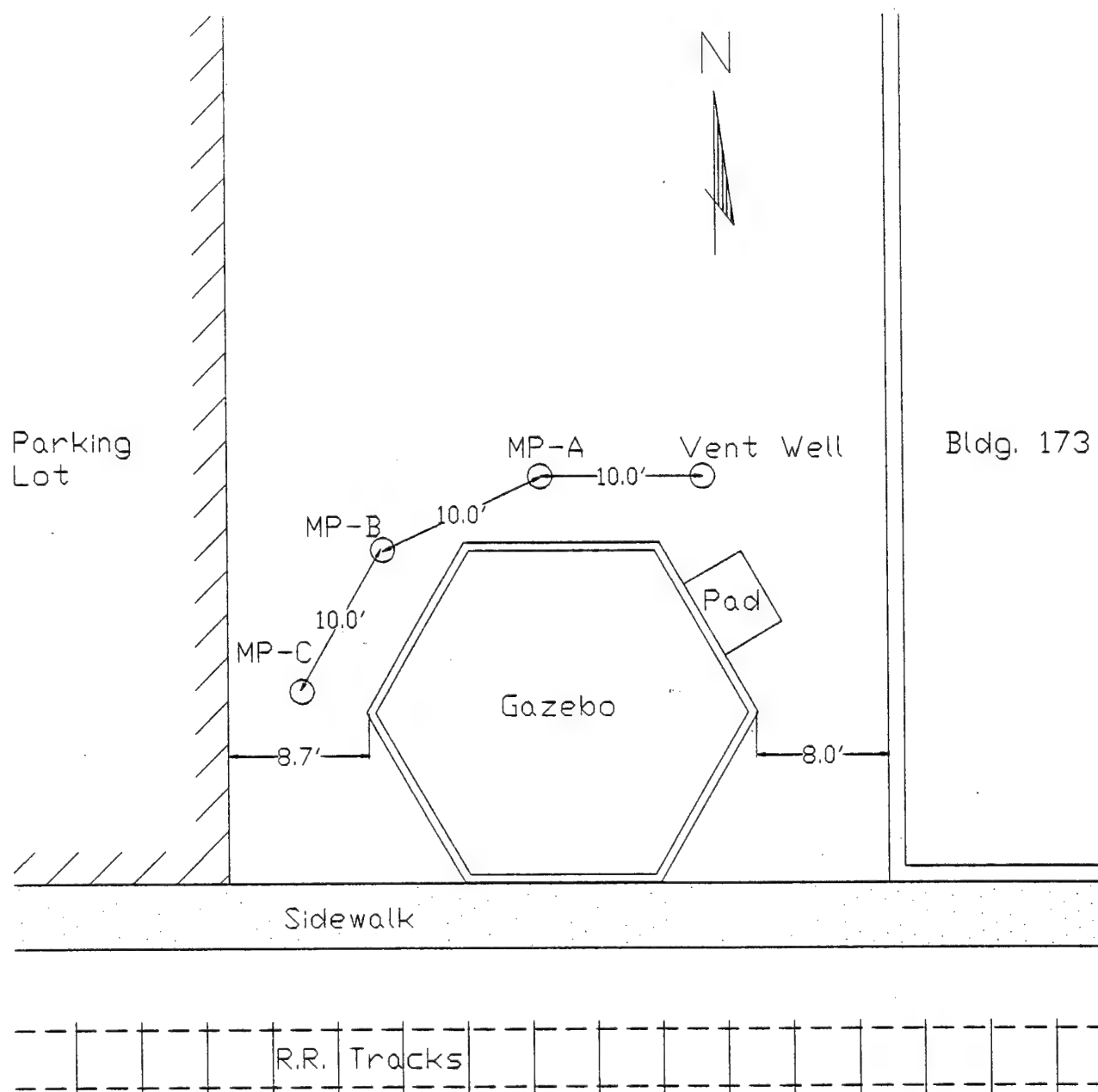


Figure 2. Schematic Diagram of Site UST 173 at Robins AFB

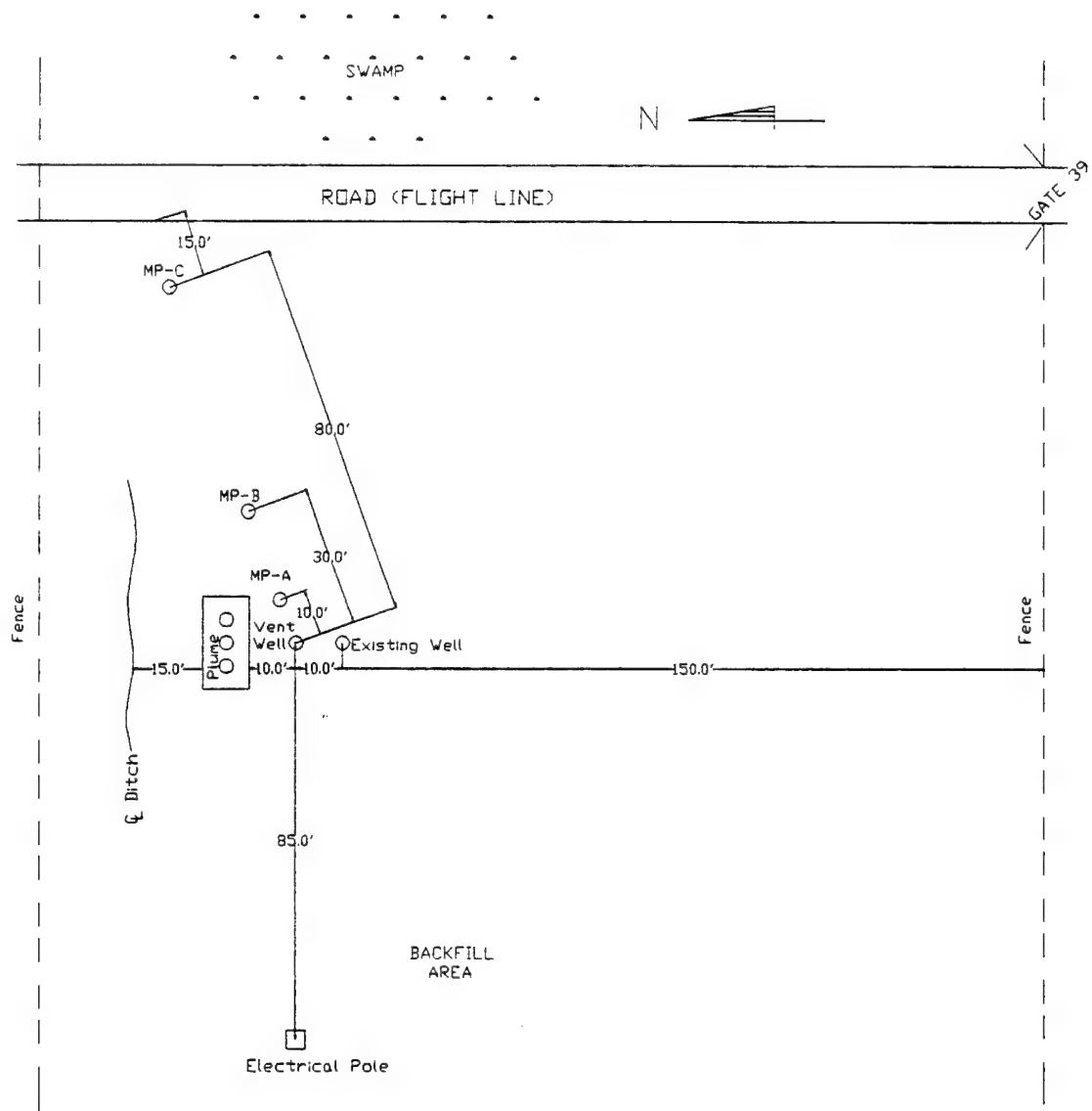


Figure 3. Schematic Diagram of Site SS-10 at Robins AFB



## 2.0 SITE 272

A site deemed suitable for the bioventing demonstration should have soil gas characteristics of low oxygen, high carbon dioxide, and high TPH. This composition of soil gas would indicate that oxygen-limiting conditions for microbial activity are present and that the introduction of air may enhance biodegradation of TPH.

A limited soil gas survey was conducted on August 24, 1992 to locate a suitable test area at Site 272. Soil gases were sampled by driving a 5/8-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH.

Measurements of oxygen and carbon dioxide in the soil gas were made with a GasTech Model 32530X with oxygen and carbon dioxide ranges of 0 to 25%. The analyzer was calibrated daily against atmospheric oxygen, atmospheric carbon dioxide, a 10% oxygen calibration standard, and a 5% carbon dioxide calibration standard. TPH was measured with a GasTech Trace Techtor with TPH ranges from 0 to 100, 0 to 1,000, and 0 to 10,000 ppm. The GasTech Trace Techtor was calibrated daily against a 4,200 ppm hexane standard.

Soil boring logs were not available for this site; however, the site geology is likely to be similar to that of Site UST 173, with groundwater at depths greater than 25 ft.

The soil gas probes were driven to depths ranging from 2.5 to 10.0 feet at several locations at Site 272. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site 272. Oxygen concentrations ranged from 5 to 21.0%, with the majority of oxygen concentrations above 16%. TPH concentrations were low, with all measurements below 200 ppm. These results indicate that there is little contamination at this site, and it is unlikely that installation of a bioventing system would be practical.

Table 1. Initial Soil Gas Composition at Site 272

Soil Gas Survey (GS) Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	NM <sup>1</sup>	5.9	80
	5	14.0	5.5	155
	7.5	16.5	5.5	200
	10	16.5	6.0	200
GS-2	2.5	NM <sup>1</sup>	6.0	84
	5	14.8	6.0	180
	7.5	21.0 <sup>2</sup>	0.5	32
	10	21.0 <sup>2</sup>	0.5	45
GS-3	2.5	NM <sup>1</sup>	4.5	66
	5	16.0	4.2	135
	7.5	18.0	4.0	120
	10	17.0	5.5	150
GS-4	2.5	17.3 <sup>2</sup>	3.8	125
	5	19.0	2.5	110
	7.5	19.5 <sup>2</sup>	2.0	100
	10	20.0 <sup>2</sup>	1.0	120
GS-5	2.5	19.0 <sup>2</sup>	2.5	120
	5	15.0	5.0	130
	7.5	17.0	5.5	140
	10	17.0	5.5	130
GS-6	2.5	15.0	6.0	140
	5	16.5 <sup>2</sup>	6.0	150
	7.5	16.0	6.9	160
GS-7	2.5	12.0	7.5	320
	5	18.0 <sup>2</sup>	4.0	130
	7.5	19.9 <sup>2</sup>	1.9	84
GS-8	2.5	5.0	4.9	120
	5	20.0 <sup>2</sup>	0.8	65
GS-9	2.5	14.9 <sup>2</sup>	6.5	160
	5	20.5 <sup>2</sup>	0.5	40

<sup>1</sup> NM = Not measured.<sup>2</sup> High pressure reading on vacuum pump. Measurements may be unreliable.

### 3.0 SITE UST 173

#### 3.1 Chronology of Events and Site Activities

##### 3.1.1 Soil Gas Survey

A limited soil gas survey was conducted on August 25, 1992 to locate a suitable test area at Site UST 173. Soil gases were sampled by driving a 5/8-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas samples were analyzed as described in Section 2.0.

Soil borings were advanced during previous site characterization activities to depths of approximately 25 ft. No groundwater was encountered at this site at this depth.

The soil gas probes were driven to depths ranging from 2.5 to 10.0 feet at several locations at Site UST 173. Table 2 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site UST 173. Oxygen concentrations varied from 0 to 19.2%, whereas TPH concentrations ranged from 0 to greater than 20,000 ppm. These results indicate that, although not all areas of the site are oxygen-limited, some areas may respond to bioventing.

##### 3.1.2 Vent Well and Monitoring Point Installation

On August 26, 1992, the vent well (VW) and three monitoring points were installed at Site UST 173, and collection of soil samples for analyses was begun. The monitoring points were labelled R1-MPA, R1-MPB, and R1-MPC. The locations of the vent well and monitoring points are shown in Figure 2. A cross section of the vent well and monitoring points showing site lithology is shown in Figure 4.

The vent well was installed at a depth of 23.3 feet into an 8-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with 10 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand; the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface. A schematic diagram of the vent well construction is shown in Figure 4.

Table 2. Initial Soil Gas Composition at Site UST 173

Soil Gas Survey (GS) Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	15.0 <sup>1</sup>	4.5	145
	5	11.7 <sup>1</sup>	6.5	360
	7.5	17.2 <sup>1</sup>	3.0	160
	10	11.0	8.0	620
GS-2	2.5	11.0	7.7	380
	5	19.2 <sup>1</sup>	1.5	240
	7.5	0	9.2	> 20,000
GS-3	2.5	9.5	7.2	380
	5	19.0 <sup>1</sup>	1.5	88
	7.5	12.0 <sup>1</sup>	5.6	230
	10	14.0 <sup>1</sup>	5.5	280
GS-4	2.5	12.3	5.8	360
	5	15.8 <sup>1</sup>	2.3	> 10,000
	7.5	18.0 <sup>1</sup>	1.0	1,200
	10	11.5	7.5	380
GS-5	2.5	17.0 <sup>1</sup>	3.8	40
GS-6	2.5	8.5	9.5	100
	5	15.0 <sup>1</sup>	4.2	84
GS-8	2.5	13.8 <sup>1</sup>	2.5	100
	5	17.5	4.1	0

<sup>1</sup> High pressure reading on vacuum pump. Measurements may be unreliable.

Vent Well

MPA

MPB

MPC

1 1/2" Diameter SCH 40  
PVC Header Sloped  
to Well

From Blower

Metal  
Tags

Quick  
Disconnects

Watertight  
Well Box

Concrete  
Collar

Borehole

1/4" Diameter  
Poly Tubing

1" Diameter x  
6" Long Screen

Thermocouple for  
Measuring  
Soil Temperature  
(MPA Only)

Concrete Cap

Bentonite Seal

8-12 Silica Sand

2" Diameter SCH  
40 PVC Screen,  
0.01 Slot

End Cap

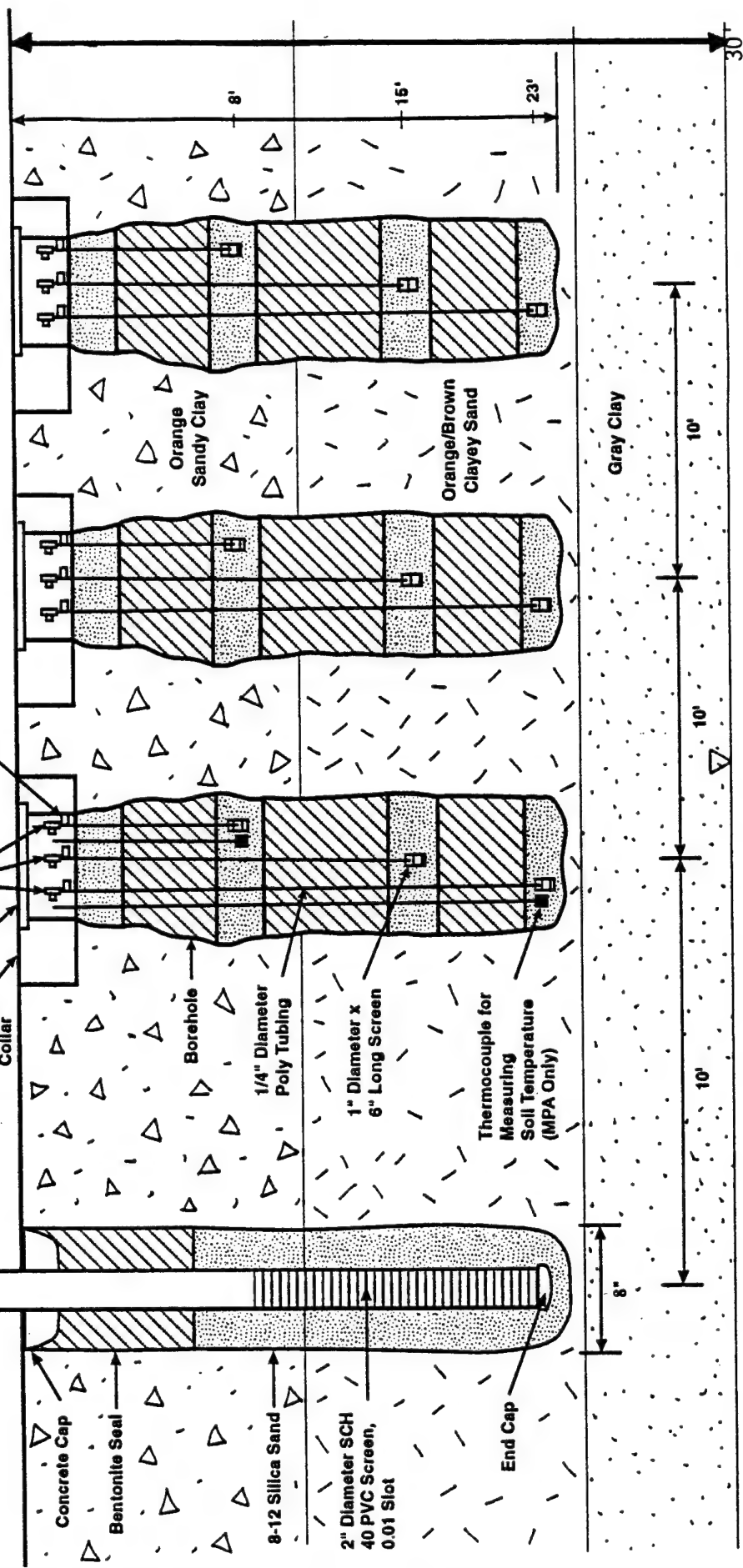


Figure 4. Cross Section of Vent Well and Monitoring Points at Site UST 173 Showing Site Lithology and Construction Detail

Soil gas probes consisted of ¼-inch tubing with a ½-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand. The interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at depths as follows:

- Monitoring point R1-MPA was installed at a depth of 22'4" into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 21'10", 14'3", and 6'10".
- Monitoring point R1-MPB was installed at a depth of 23'6" into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 23', 15', and 8'.
- Monitoring point R1-MPC was installed at a depth of 23'6" into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 23', 15', and 8'.

A schematic diagram of the construction detail of a typical monitoring point for this site is shown in Figure 4.

### **3.1.3 Soil and Soil Gas Sampling and Analyses**

Soil boring samples were collected at depths of 4.0, 18.0, and 18.5 feet from the Site UST 173 vent well borehole and were labelled R1-V-4.0-4.5, R1-V-18.0, and R1-V-18.5-19.0, respectively. The samples were sent under chain of custody to Engineering-Science Berkeley Laboratory for analyses of BTEX, TPH, iron, and soil chemistry. A soil sample was taken from monitoring point R1-MPA at a depth of 8.5 feet and labelled R1-MPA-8.5-10.0. Soil gas samples also were collected from the vent well and from monitoring points R1-MPA and R1-MPC, and a sample of ambient air was taken. These samples were labelled R1-VW, R1-MPA-21'10", R1-MPC-15, and ambient, respectively. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

### 3.1.4 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute  $k$ , the soil gas permeability, is presented in *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Hinchee et al., 1992).

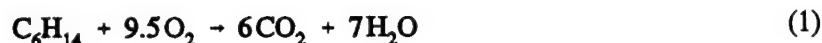
The monitoring points at Site UST 173 were allowed to set up for 24 hours prior to air injection. A portable 1-horsepower (HP) explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

### 3.1.5 In Situ Respiration Test

Immediately following the soil gas permeability test at Site UST 173, air containing approximately 1% helium was injected into the soil for approximately 24 hours beginning on September 1. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test was as described by Hinchee et al. (1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through monitoring points R1-MPA-14'3", R1-MPA-21'10", R1-MPC-15', and R1-MPC-23' at the depths indicated by the labels. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on September 8.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributed to either diffusion or leakage. A rapid drop in helium concentration followed by a leveling is an indication of leakage. A gradual loss along with an apparent first-order curve is an indicator of diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses about 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations are at least 50% to 60% of the initial levels at test completion, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

To compare data from one site to another, a stoichiometric relationship of the oxidation of the hydrocarbon was assumed. Hexane was used as the representative hydrocarbon for the organic contaminant. The stoichiometric relationship is given by:



Based on the utilization rates (% per day), the biodegradation rates in terms of mg as a hexane equivalent per kg of soil per day were computed using the equation below by assuming a soil porosity of 0.2 and a bulk density of 1,440 kg/m<sup>3</sup>.

$$K_b = \frac{-K_o A D_o C}{100} \quad (2)$$

where:  $K_b$  = biodegradation rate (mg/kg/day)

$K_o$  = oxygen utilization rate (percent per day)

$A$  = volume of air/kg of soil, in this case  $300/1,440 = 0.21$

$D_o$  = density of oxygen gas (mg/L) assumed to be 1,330 mg/L

$C$  = mass ratio of hydrocarbon to oxygen required for mineralization, assumed to be 1:3.5 from the above stoichiometric equation.

## 3.2 Results and Discussion

### 3.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at Site UST 173 are presented in Table 3. Relatively low concentrations of the BTEX compounds were found in soil samples, with concentrations ranging from below the detection limit to 3.0 mg/kg. TPH concentrations were high in sample R1-MPA-8.5'-10.0', while the other soil samples contained relatively low TPH concentrations. The soil gas analyses also showed relatively low BTEX and TPH concentrations with concentrations ranging from less than the detection limit up to 2.2 ppm of BTEX and from 27 to 300 ppm of TPH (Table 3). The results from the soil chemistry analyses are summarized in Table 4. The laboratory report for the BTEX, TPH, and the soil chemistry analyses is given in Appendix A.



Table 3. Results From Soil and Soil Gas Analyses for BTEX and TPH at Site UST 173

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH <sup>1</sup> (mg/kg)
Soil	R1-V-4.0'-4.5'	<0.29	<0.33	0.33	3.0	37
	R1-V-18.5'-19.0'	<0.0007	<0.0008	<0.0006	0.0037	8.0
	R1-MPA-8.5'-10.0'	<0.0007	0.002	0.009	0.079	5,700
Matrix	Sample Name	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm)	TPH <sup>1</sup> (ppm)
Soil Gas	R1-VW	<0.004	0.025	0.31	2.2	300
	R1-MPA-21'10"	<0.002	0.052	0.055	0.81	290
	R1-MPC-15'	<0.002	0.006	0.14	0.098	27
	Ambient Air <sup>2</sup>	<0.002	<0.002	<0.002	<0.002	0.20

<sup>1</sup> TPH referenced to gasoline (Molecular Weight = 100)<sup>2</sup> Sample taken at R1-MPA.

Table 4. Results From Soil Chemistry Analyses at Site UST 173

Parameter	Sample Name		
	R1-V-4.0'-4.5'	R1-V-18'	R1-MPA-8.5'-10.0'
Alkalinity (mg/kg CaCO <sub>3</sub> )	< 50	< 50	< 50
Moisture (% by weight)	16.2	9.1	17.5
pH	4.9	5.4	5.2
Iron (mg/kg)	11,300	4,720	1,980
Total Phosphorous (mg/kg)	110	64	79
Total Kjeldahl Nitrogen (mg/kg)	110	92	68
Particle Size Analysis	Gravel: 0%	Gravel: 3%	Gravel: 0%
	Sand: 49%	Sand: 40%	Sand: 59%
	Silt: 20%	Silt: 37%	Silt: 22%
	Clay: 31%	Clay: 20%	Clay: 19%

### 3.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Site UST 173 are presented in Appendix B. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 5. The soil gas permeability varied considerably between points with values ranging from 0.05 up to 10,200 darcy. The radius of influence where 1 inch of pressure was measured was calculated by plotting the log of the pressure change at the monitoring points versus the distance from the vent well (Figure 5). The radius of influence at Site UST 173 is estimated to be approximately 28 feet.

### 3.2.3 In Situ Respiration Test

The results of the in situ respiration test for Site UST 173 are presented in Appendix C. Each figure in Appendix C illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization and carbon dioxide production at this site is shown in Figure 6, which shows oxygen, carbon dioxide, and helium at monitoring point R1-MPA-14'3". Oxygen utilization and carbon dioxide production rates were relatively low at this site at all monitoring points. The rates of oxygen utilization and carbon dioxide production and the

**Table 5. Results of Hyperventilate™ Soil Gas Permeability Analysis**

Monitoring Point	Depth	Soil Gas Permeability (darcy)
R1-MPA	6'10"	0.050
	14'3"	570
	21'10"	10,200
R1-MPB	8'	180
	15'	320
	23'	140
R1-MPC	8'	44
	15'	0.17
	23'	770

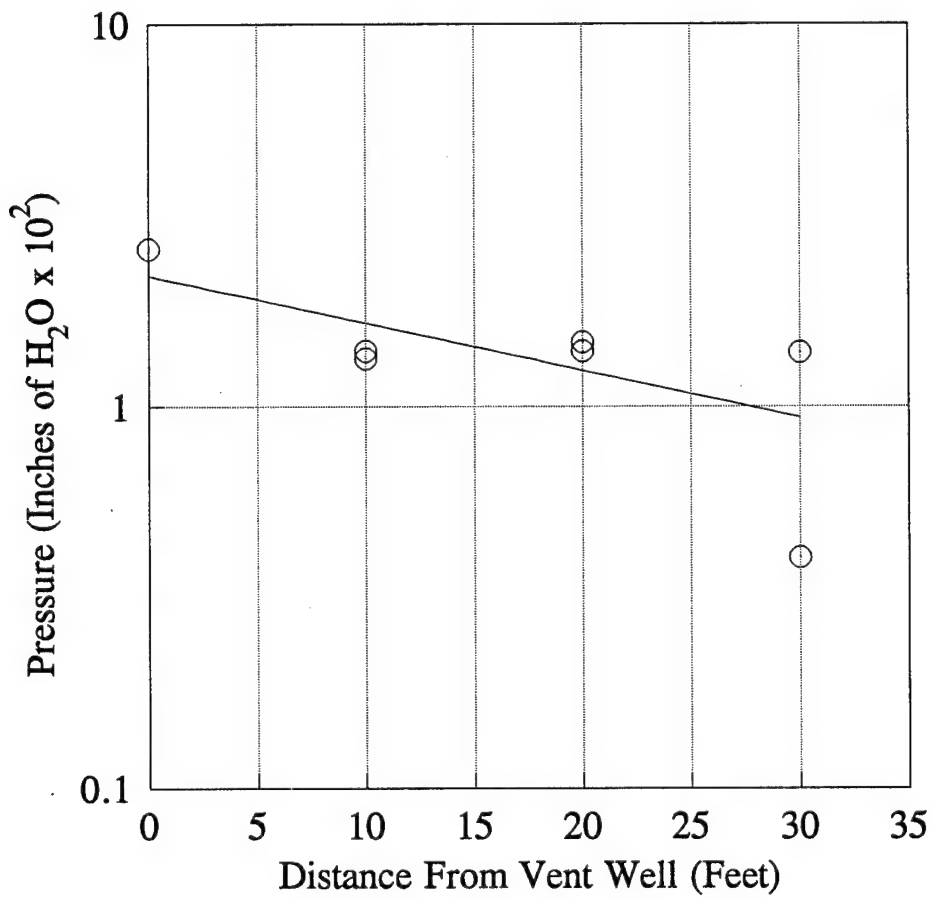


Figure 5. Radius of Influence at Site UST 173

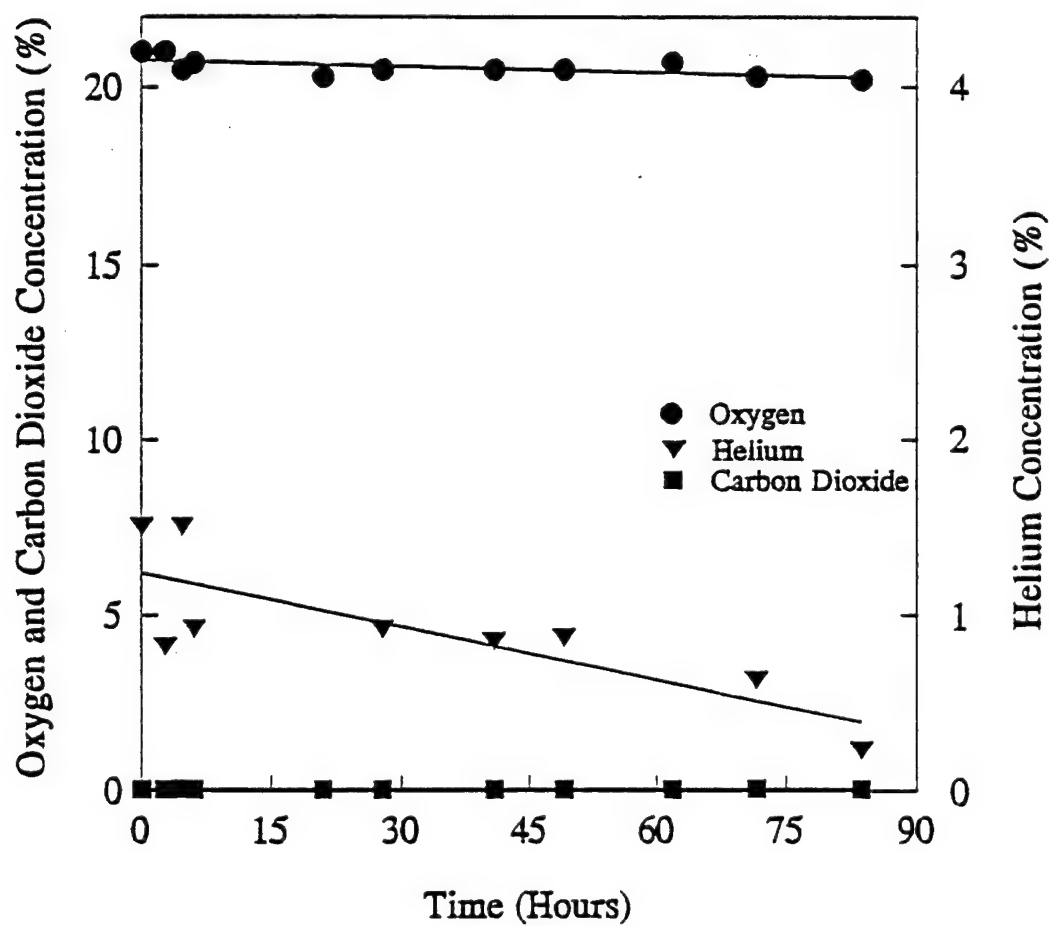


Figure 6. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Site UST 173 Monitoring Point R1-MPA-14'3"

corresponding biodegradation rates are summarized in Table 6. The biodegradation rates measured at this site were fairly consistent between the monitoring points, with rates ranging from 0.38 to 0.75 mg/kg/day based upon oxygen and from 0.31 to 0.68 mg/kg/day for carbon dioxide, with a fairly good correlation between the oxygen utilization and carbon dioxide production rates.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well-sealed and that the oxygen depletion observed was a result of biodegradation.

### 3.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at Site UST 173. The same blower that was used for the soil gas permeability test was installed for the bioventing system. Continuous air injection was initiated on September 4th at a flow rate of 12 cubic feet per minute (cfm).

**Table 6. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at Site UST 173**

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0	0	0	0
R1-MPA-14'3"	0.039	0.75	0.015	0.31
R1-MPA-21'10"	0.028	0.54	0.031	0.68
R1-MPC-15'	0.029	0.56	0.024	0.51
R1-MPC-23'	0.020	0.38	0.015	0.31

#### 4.0 SITE SS-10

##### 4.1 Chronology of Events and Site Activities

###### 4.1.1 Soil Gas Survey

A limited soil gas survey was conducted on September 1, 1992 to locate a suitable test area at Site SS-10. Soil gases were sampled by driving a 5/8-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Measurements of oxygen, carbon dioxide, and TPH in the soil gas were made as described in Section 2.0.

The groundwater level measured at Well RI-4-JP6W, shown as the existing well in Figure 3, was 7.74 ft. Two other monitoring wells, RI-4-JP7W and LF1-3, were accessible for groundwater measurement, with levels measured at 7.22 and 7.48 feet, respectively.

The soil gas probes were driven to depths ranging from 2.5 to 7.5 feet at several locations at Site SS-10. Table 7 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site SS-10. Oxygen concentrations varied from 0 to 20.5%, whereas TPH concentrations ranged from 4 to greater than 20,000 ppm. These results indicate that, although not all areas of the site are oxygen-limited, some areas may respond to bioventing.

###### 4.1.2 Vent Well and Monitoring Point Installation

On September 1, 1992, the vent well and three monitoring points were installed at Site SS-10, and collection of soil samples for analyses was begun. Groundwater was encountered at 10 feet. The monitoring points were labelled R2-MPA, R2-MPB, and R2-MPC. The location of the vent well and monitoring points is shown in Figure 3. A cross section of the vent well and monitoring points showing site lithology is shown in Figure 7.

The vent well was installed at a depth of 7'3" into an 8-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with 5 feet of ten-slot screen from 2 feet to 7 feet. The annular space corresponding to the screened area of the well was filled with silica sand; the annular space above the screened interval was filled with

Table 7. Initial Soil Gas Composition at Site SS-10

Soil Gas Survey (GS) Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	20 <sup>1</sup>	0.1	4
	5	0	25	> 20,000
GS-2	2.5	5.0 <sup>1</sup>	6.5	280
	5	20.5 <sup>1</sup>	0.5	230
	7.5	20 <sup>1</sup>	0.6	620
GS-3	2.5	15.8 <sup>1</sup>	5.8	> 10,000
	5	3.0 <sup>1</sup>	20	> 10,000
GS-5	5	0	> 25	> 20,000
GS-6	2.5	1.5	> 25	> 10,000

<sup>1</sup> High pressure reading on vacuum pump. Measurements may be unreliable.

bentonite to prevent short-circuiting of air to or from the surface. A schematic diagram of the vent well construction is shown in Figure 7.

Soil gas probes consisted of ¼-inch tubing with a 3-inch screened area ¾ inch in diameter. The annular space corresponding to the screened area was filled with silica sand. The interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed as follows:

- Monitoring point R2-MPA was installed at a depth of 7'6" into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 6', 4.5', and 3'.
- Monitoring point R2-MPB was installed at a depth of 7'5" into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 6', 4.5', and 3'.
- Monitoring point R2-MPC was installed at a depth of 8' into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 6', 4.5', and 3'.

A schematic diagram of the construction detail of a typical monitoring point for this site is shown in Figure 7.

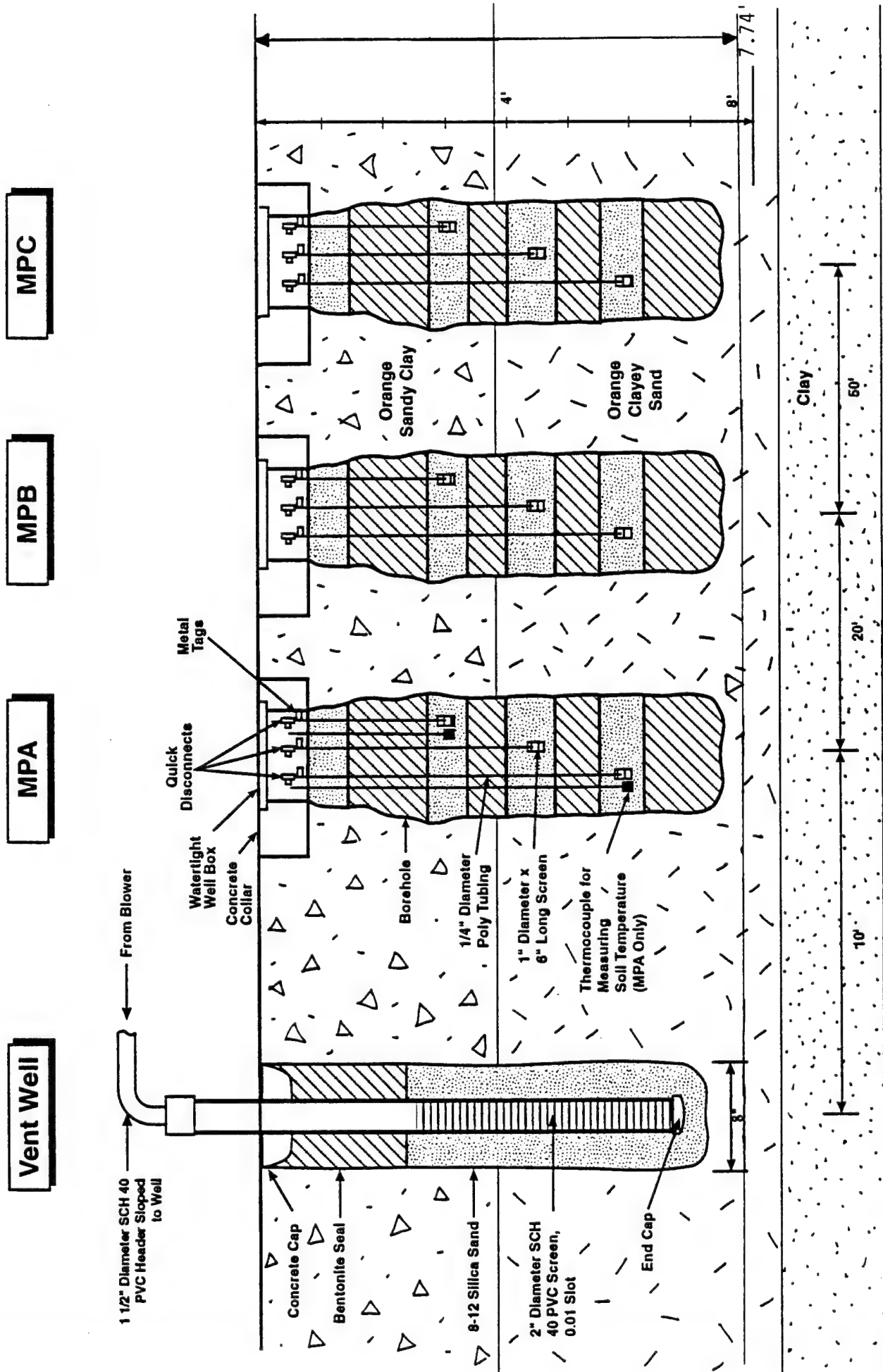


Figure 7. Cross Section of Vent Well and Monitoring Points Location at Site SS-10 Showing Site Lithology and Construction Detail



#### 4.1.3 Soil and Soil Gas Sampling and Analyses

A soil boring sample was collected at a depth of 7'3" from the Site SS-10 vent well borehole and was labelled R2-V-7'3". The sample was sent under chain of custody to Engineering-Science Berkeley Laboratory for analyses of BTEX, TPH, iron, and soil chemistry. Soil samples were taken from monitoring point R2-MPA at depths of 3.0 feet and 4.5 feet and were labelled R2-MPA-3.0'-4.0' and R2-MPA-4.5'-5.0', respectively. Soil gas samples were also collected from the vent well and from monitoring points R2-MPA-5' and R2-MPC-8', and a sample of ambient air was taken. These samples were labelled R2-VW, R2-MPA-5', R2-MPC-8', and ambient, respectively. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

#### 4.1.4 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute  $k$ , the soil gas permeability, is presented by Hinchee et al. (1992).

The monitoring points at Site SS-10 were allowed to set up for 24 hours prior to air injection. A portable 2.5-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

#### 4.1.5 In Situ Respiration Test

Immediately following the soil gas permeability test at Site SS-10, air containing approximately 1% helium was injected into the soil for approximately 24 hours beginning on September 4. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test was as described by Hinchee et al. (1992). The pump used for air injection was a 1/2-HP diaphragm pump. Air and helium were injected through monitoring points R2-MPA-6', R2-MPC-6', R2-MPC-4.5', and R2-MPA-4.5' at the depths indicated by the labels. After the air/helium injection was turned off, the

respiration gases were monitored periodically. The respiration test was terminated on September 9. Results of the in situ respiration were calculated as described in Section 3.1.5.

## 4.2 Results and Discussion

### 4.2.1 Soil and Soil Gas Analyses

In general, water-saturated conditions at Site SS-10 were encountered at a depth of approximately 10 feet. Results of the soil analyses for BTEX and TPH are presented in Table 8. Relatively high concentrations of toluene, ethylbenzene, and xylenes were found in soil samples from the vent well, with concentrations ranging from 39 to 220 mg/kg. Lower concentrations were found at monitoring point A (0.098 to 6.8 mg/kg), and benzene was detected only in sample R2-A-3'-3'6". TPH concentrations were highest in the soil sample from the vent well (9,000 mg/kg), while concentrations of 58 and 150 mg/kg were detected in the soil samples from monitoring point A. The soil gas analyses also showed high BTEX and TPH concentrations, with concentrations ranging from 11 to 330 ppm of BTEX, with benzene at the highest concentration, and from 42,000 to 72,000 ppm of TPH (Table 8). The results from the soil chemistry analyses are summarized in Table 9. The laboratory report for the BTEX, TPH, and the soil chemistry analyses is given in Appendix D.

**Table 8. Results From Soil and Soil Gas Analyses for BTEX and TPH at Site SS-10**

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH <sup>1</sup> (mg/kg)
Soil	R2-V-7'3"	< 1.3	59	39	220	9,000
	R2-A-3'-3'6"	0.053	0.098	0.054	0.54	150
	R2-A-5'-5'6"	< 0.26	0.70	2.0	6.8	58
Matrix	Sample Name	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm)	TPH <sup>1</sup> (ppm)
Soil Gas	R2-VW	260	120	11	81	42,000
	R2-MPA-5'	220	87	14	72	50,000
	R2-MPC-8'	330	120	22	100	72,000
	Ambient Air <sup>2</sup>	< 0.002	< 0.002	< 0.002	< 0.002	0.55

<sup>1</sup> TPH referenced to gasoline (Molecular Weight = 100)

<sup>2</sup> Sample taken at Site SS-10 between vent well and R2-MPA.

Table 9. Results From Soil Chemistry Analyses at Site SS-10

Parameter	Sample Name		
	R2-V-7'3"	R2-A-5'-5'6"	R2-A-3'-3'6"
Alkalinity (mg/kg $\text{CaCO}_3$ )	< 50	< 50	< 50
Moisture (% by weight)	8.2	11.8	9.8
pH	5.2	5.0	5.8
Iron (mg/kg)	1,780	4,070	4,960
Total Phosphorous (mg/kg)	43	81	110
Total Kjeldahl Nitrogen (mg/kg)	37	31	70
Particle Size Analysis	Gravel: 0%	Gravel: 0%	Gravel: 4%
	Sand: 61%	Sand: 49%	Sand: 57%
	Silt: 25%	Silt: 25%	Silt: 19%
	Clay: 14%	Clay: 26%	Clay: 20%

#### 4.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Site SS-10 are presented in Appendix E. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data appear in Table 10. The soil gas permeability varied considerably between points with values ranging from 1.5 up to  $1.01 \times 10^9$  darcy. The radius of influence where 1 inch of pressure was measured was calculated by plotting the log of the pressure change at the monitoring points versus the distance from the vent well (Figure 8). The radius of influence at Site SS-10 is estimated to be approximately 75 feet.

**Table 10. Results of Hyperventilate™ Soil Gas Permeability Analysis**

Monitoring Point	Depth	Soil Gas Permeability (darcy)
R2-MPA	3'	1.01 x E9
	4'6"	5.3 x E8
	6'	9.9 x E9
R2-MPB	3'	2.4 x E6
	4'6"	4.3 x E5
	6'	8.1 x E5
R2-MPC	3'	1.5
	4'6"	340
	6'	670

#### 4.2.3 In Situ Respiration Test

The results of the in situ respiration test for Site SS-10 are presented in Appendix F. Each figure in Appendix F illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization and carbon dioxide production at this site is shown in Figure 9, which shows oxygen, carbon dioxide, and helium at monitoring point R2-MPC-6'. These results are typical for oxygen utilization and carbon dioxide production at monitoring point R2-MPC, while the rates were somewhat slower at monitoring point R2-MPA. The rates of oxygen utilization and carbon dioxide production and the corresponding biodegradation rates are summarized in Table 11. The biodegradation rates measured at this site ranged from 1.2 to 6.4 mg/kg/day based upon oxygen and from 0.19 to 0.57 mg/kg/day for carbon dioxide. Biodegradation rates based upon carbon dioxide production were consistently lower than those calculated based upon oxygen utilization, suggesting that carbon dioxide was reacting chemically in the soil.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

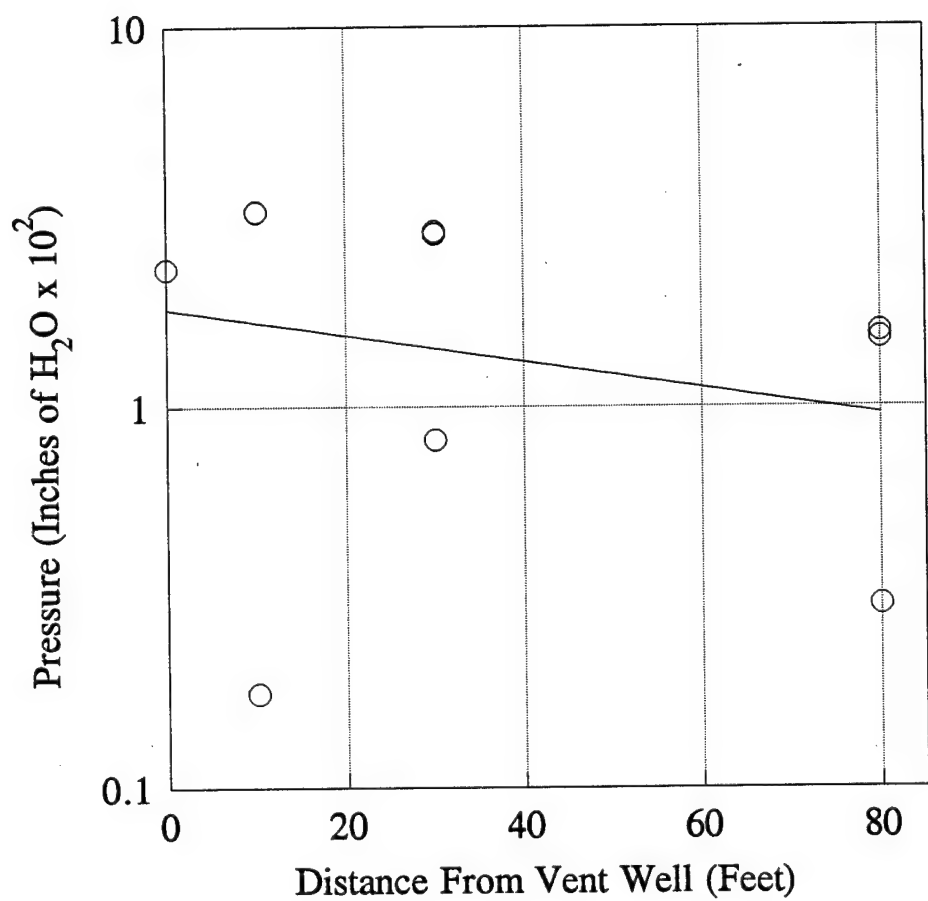


Figure 8. Calculation of Radius of Influence at Site SS-10

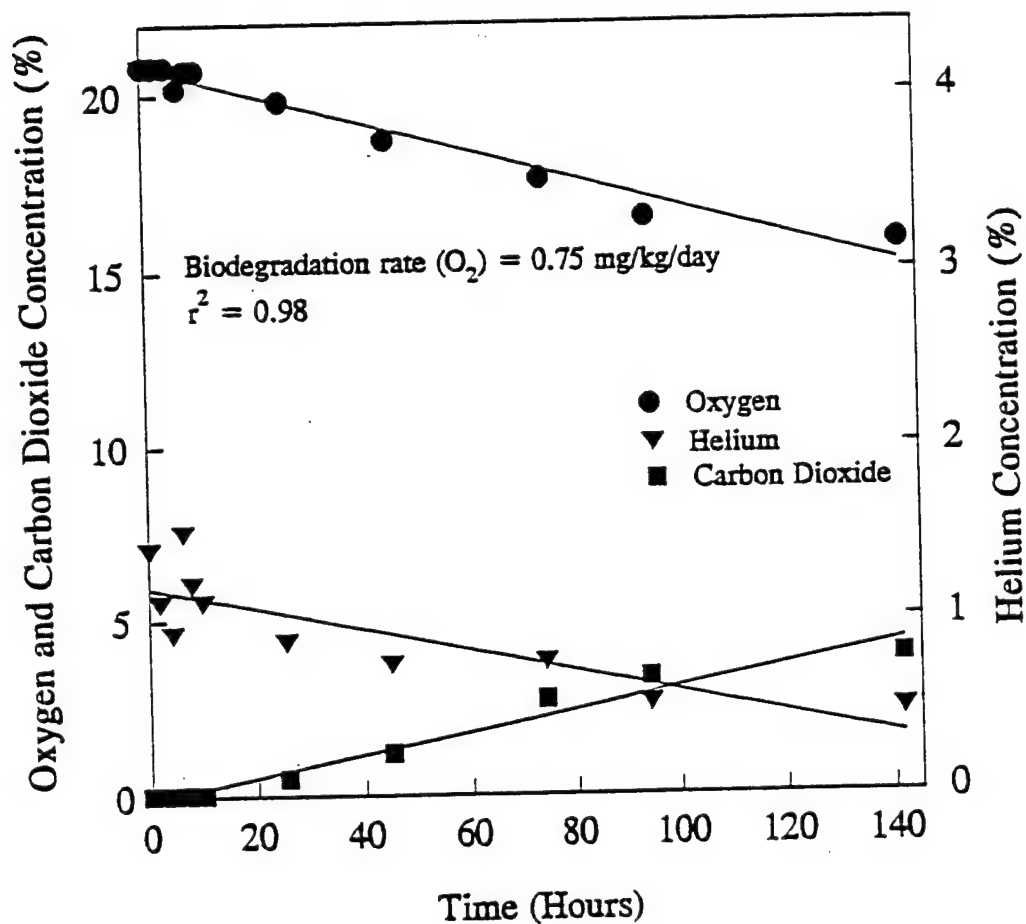


Figure 9. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Site SS-10 Monitoring Point R2-MPC-6'

**Table 11. Oxygen Utilization Rates and Carbon Dioxide Production During the In Situ Respiration Test at Site SS-10**

<b>Sample Name</b>	<b>Oxygen Utilization Rate (%/hour)</b>	<b>Biodegradation Rate (mg/kg/day)</b>	<b>Carbon Dioxide Utilization Rate (%/hour)</b>	<b>Biodegradation Rate (mg/kg/day)</b>
Background	0	0	0	0
R2-MPA-4'6"	0.061	1.2	0.0086	0.19
R2-MPA-6'	0.074	1.4	0.0095	0.20
R2-MPC-4'6"	0.34	6.4	0.024	0.51
R2-MPC-6'	0.26	5.0	0.026	0.57

#### **4.2.4 Bioventing Demonstration**

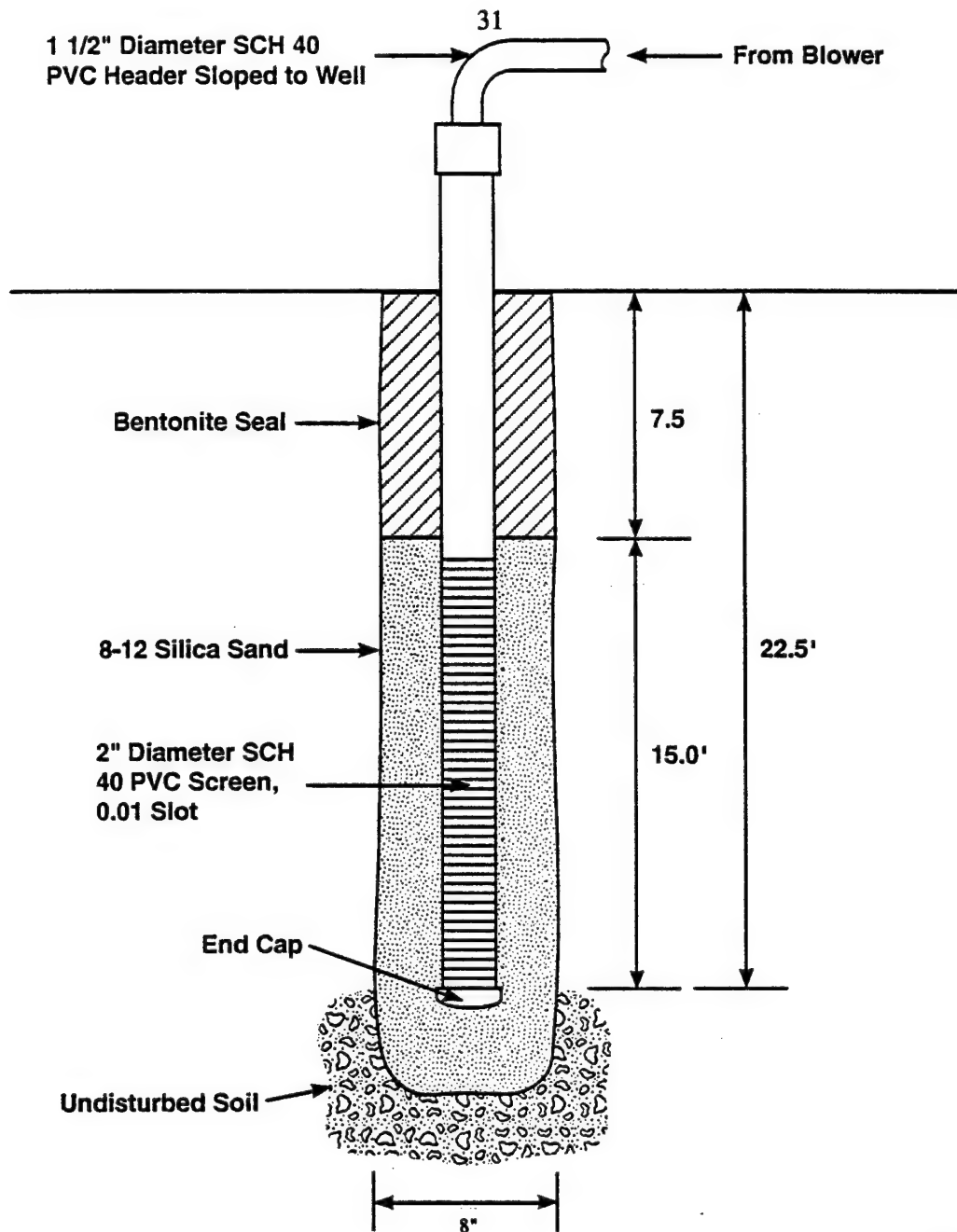
The decision was made to install a bioventing system at Site SS-10. The same blower that was used for the soil gas permeability test was installed for the bioventing system. Continuous air injection was initiated on September 10 at a flow rate of 27 cubic feet per minute (cfm).

## 5.0 BACKGROUND AREA

A background vent well was installed on August 31, 1992. The depth of this vent well was 23 feet. Ten feet were screened using Schedule 40, 2-inch-diameter, 10-slot PVC, and the remaining 13 feet consisted of Schedule 40, 2-inch-diameter PVC riser. The first 15 feet of the vent well were surrounded by sand, while 6 of the remaining 8 feet were enclosed by bentonite to seal the vent well. A schematic diagram of the vent well construction is shown in Figure 10.

An in situ respiration test was conducted at the background area beginning on September 5 after 24 hours of air injection. The test was concluded on September 9. No significant biodegradation was detected in this area, as shown in Figure 11.





FKIHW11-03

Figure 10. Schematic Diagram of Vent Well Construction at the Background Area

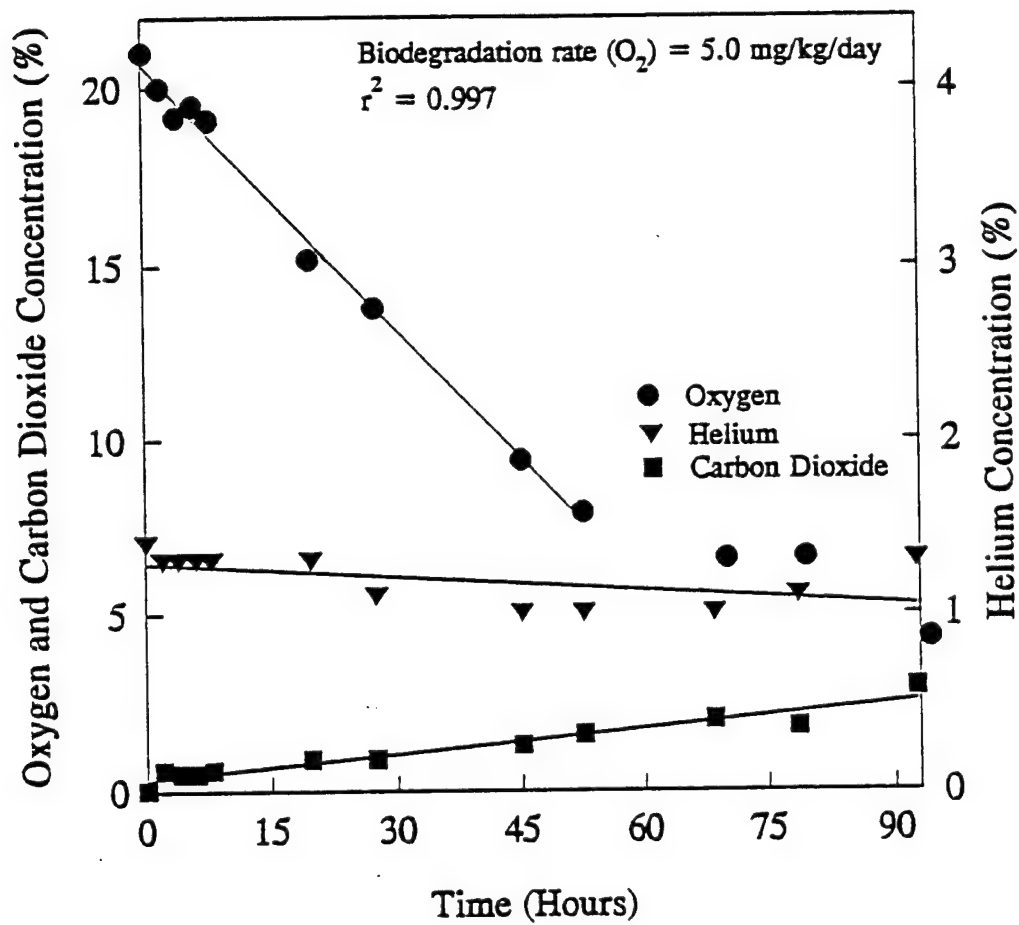


Figure 11. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Background Area

## 6.0 FUTURE WORK

Base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flow rate, pressure, and temperature range. This check must be coordinated with the base point of contact (POC). An on-site briefing was conducted for base personnel who will be responsible for blower system checks. The principle of operation was explained, and a simple checklist and logbook were provided for blower data. Base personnel will perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base and serious problems, such as motor or blower failures, will be corrected by Battelle.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point, and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. Soil gas monitoring will be performed on a quarterly basis. Semiannual respiration tests will be performed. At least twice each year, the progress of the bioventing test will be reported to the base POC.

## 7.0 REFERENCE

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

**APPENDIX A**  
**ANALYTICAL REPORT FOR SITE UST 173**

**@ AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

**WORK ORDER #: 9209004**

## Work Order Summary

**CLIENT:** Mr. Jeff Kittel  
Battelle  
505 King Ave.  
Columbus, OH 43201

**BILL TO:** Accounts Payable  
Engineering Science  
1700 Broadway Ste. 900  
Denver, CO 80290

**PHONE:** 614-424-6122

**FAX:** 614-424-3667

**DATE RECEIVED:** 9/1/92

**DATE REPORTED:** 9/8/92

**INVOICE #** 8415

**P.O. #** DE268.03

**AMOUNT:** \$565.98

**PROJECT #** E-S JOB DE268.03

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>Receipt</u> <u>VAC./Press.</u>	<u>PRICE</u>
01A	R1-V	TO-3	0.5 "Hg	\$120.00
02A	R1-C	TO-3	1.5 "Hg	\$120.00
03A	Ambient -R1	TO-3	0 "Hg	\$120.00
04A	R1-A	TO-3	1.0 "Hg	\$120.00
05A	Lab Blank	TO-3	NA	NC

Misc. Charges	1 Liter SUMMA Canister Preparation (4) @ \$10.00 each.	\$40.00
	Shipping (8/27/92)	\$45.98

REVIEWED BY: [Signature]

DATE: 9/9/92

CERTIFIED BY: [Signature]

DATE: 9/9/92

**AIR TOXICS LTD.**

SAMPLE NAME: R1-V

ID#: 9209004-01A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090305	Date of Collection:		8/30/92
Dil. Factor:		4.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.004	0.013	Not Detected	Not Detected	
Toluene	0.004	0.015	0.025	0.092	
Total Xylenes	0.004	0.017	2.2	9.3	
Ethyl Benzene	0.004	0.017	0.31	1.3	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090305	Date of Collection:		8/30/92
Dil. Factor:		4.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.041	0.16	300	1200	

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R1-C

ID#: 9209004-02A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090306	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.002	0.007	Not Detected	Not Detected	
Toluene	0.002	0.007	0.006	0.019	
Total Xylenes	0.002	0.007	0.098	0.31	
Ethyl Benzene	0.002	0.007	0.14	0.44	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090306	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.021	0.084	27	110	

\*TPH referenced to Jet Fuel (MW=156)



**AIR TOXICS LTD.**

SAMPLE NAME: Ambient -R1

ID#: 9209004-03A

**EPA Method TO-3**

(Aromatic Volatile Organics in Air)

**BTXE BY GC/PID**

<b>File Name:</b>		<b>6090308</b>	<b>Date of Collection:</b>		<b>8/30/92</b>
<b>Dil. Factor:</b>		<b>2.0</b>	<b>Date of Analysis:</b>		<b>9/3/92</b>
	<b>MDL</b>	<b>MDL</b>	<b>Amount</b>	<b>Amount</b>	
<b>Compound</b>	<b>(ppmv)</b>	<b>(uG/L)</b>	<b>(ppmv)</b>	<b>(uG/L)</b>	
Benzene	0.002	0.006	Not Detected	Not Detected	
Toluene	0.002	0.007	Not Detected	Not Detected	
Total Xylenes	0.002	0.008	Not Detected	Not Detected	
Ethyl Benzene	0.002	0.008	Not Detected	Not Detected	

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>		<b>6090308</b>	<b>Date of Collection:</b>		<b>8/30/92</b>
<b>Dil. Factor:</b>		<b>2.0</b>	<b>Date of Analysis:</b>		<b>9/3/92</b>
	<b>MDL</b>	<b>MDL</b>	<b>Amount</b>	<b>Amount</b>	
<b>Compound</b>	<b>(ppmv)</b>	<b>(uG/L)</b>	<b>(ppmv)</b>	<b>(uG/L)</b>	
TPH*	0.020	0.080	0.20	0.80	

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R1-A

ID#: 9209004-04A

**EPA Method TO-3**

(Aromatic Volatile Organics in Air)

**BTXE BY GC/PID**

File Name:		6090309	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.002	0.007	Not Detected	Not Detected	
Toluene	0.002	0.008	0.052	0.19	
Total Xylenes	0.002	0.009	0.81	3.4	
Ethyl Benzene	0.002	0.009	0.055	0.23	

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

File Name:		6090309	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.021	0.084	290	1200	

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: Lab Blank

ID#: 9209004-05A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090303	Date of Collection:		NA
Dil. Factor:		1.0	Date of Analysis:		9/3/92
	MDL	MDL	Amount	Amount	
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)	
Benzene	0.001	0.003	Not Detected	Not Detected	
Toluene	0.001	0.004	Not Detected	Not Detected	
Total Xylenes	0.001	0.004	Not Detected	Not Detected	
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:	6090303	Date of Collection:	NA	
Dil. Factor:	1.0	Date of Analysis:	9/3/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.010	0.040	Not Detected	Not Detected

\*TPH referenced to Jet Fuel (MW=156)



**CHAIN OF CUSTODY RECORD**

Form No.

## CHAIN OF CUSTODY RECORD

[illegible]



ENGINEERING-SCIENCE, INC.

RESEARCH AND DEVELOPMENT  
LABORATORY  
600 BANCROFT WAY  
BERKELEY, CALIFORNIA 94710  
(415) 841-7353

Report Date: October 9, 1992

Work Order No.: 4294

Client: Jeff Kittel  
Battelle  
505 King Ave.  
Columbus, OH 43201

Date of Sample Receipt: 09/01/92

Your soil samples identified as:

R1-A-8.5'-10

R1-V-4.0'-4.5'

were analyzed for BTEX by EPA Method 8020, pH, alkalinity, iron, total Kjeldahl nitrogen, moisture, TRPH by EPA Method 418.1, soil classification by ASTM D422 and total phosphorus.

In addition your soil sample identified as:

R1-V-18'

was analyzed for pH, alkalinity, iron, total Kjeldahl nitrogen, moisture soil classification by ASTM D422 and total phosphorus.

Finally your soil sample identified as:

R1-V-18.5-19'

was analyzed for BTEX by EPA Method 8020 and TRPH by EPA Method 418.1.

The analytical reports for the samples listed above are attached.

LEGEND FOR INORGANIC RESULT QUALIFIERS

- U The analyte was analyzed for but not detected.
- B Reported value is less than Reporting limit but greater than the IDL.
- N Spiked sample recovery not within control limits.
- S Reported value was determined by the Method of Standard Additions.
- \* Duplicate analysis not within control limits.
- W Post digestion spike for Furance AA analysis out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance
- + Correlation co-efficient for MSA is less than 0.995.
- E The reported value is estimated because of the presence of interference.
- R Quality Control indicates that data are not usable (compound may or may not be present). Re-sampling and re-analysis is necessary for verification.
- M Duplicate injection precision not met.

**GC VOLATILES DATA PACKAGE**

GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture: 17.5

Client ID:R1-A-8.5'-10'

Matrix:SOIL

Laboratory ID:4294-1

Level:LOW

Unit:ug/KG

Dilution Factor: 1


Date Analyzed:09/04/92

Date Confirmed:09/08/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.7
Ethyl Benzene	6.3	9.0	0.6
Toluene	2.7	2.0	0.8
Xylenes (total)	89.6	79.0	1.1

ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: AD

GROUP LEADER: 



-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture: 16.2

Client ID:R1-V-4.0'-4.5'

Matrix:SOIL

Laboratory ID:4294-2

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 4


Date Analyzed:09/08/92

Date Confirmed:09/09/92  
-----

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	290.0
Ethyl Benzene	330.0	330.0	240.0
Toluene	ND	ND	330.0
Xylenes (total)	1200	3000.0	430.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: AM

GROUP LEADER: 

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture: 14.9

Client ID:R1-V-18.5'-19'

Matrix:SOIL

Laboratory ID:4294-4

Level:LOW

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/08/92  
Date Confirmed:09/04/92-----

Compound	Primary Result	Confirmatory Result	Reportin Limit
Benzene	ND	ND	0.7
Ethyl Benzene	ND	ND	0.6
Toluene	ND	ND	0.8
Xylenes (total)	1.1	3.7	1.0

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AB*GROUP LEADER: *fu*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MSVG5920904

Level:LOW

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/04/92  
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *MS*GROUP LEADER: *Russell*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MWVG5920909

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/09/92  
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AD*GROUP LEADER: *Rever*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MSVG3920908B

Level:LOW

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/08/92  
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AS*GROUP LEADER: *Lucret*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4294

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MWVG3920908B

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/08/92  
Date Confirmed:NA-----

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: AB

GROUP LEADER: 

METHOD BLANK SUMMARY

WO # 4294

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/08/92

LAB SAMPLE ID: MWVG3920908B

DATE EXTRACTED : NA

MATRIX : MEDIUM SOIL

INSTRUMENT ID: VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG3920908B	METHOD BLANK	09/08/92
4294-2	R1-V-4.0-4.5'	09/08/92

METHOD BLANK SUMMARY

WO # 4294

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/09/92

LAB SAMPLE ID: MWVG5920909

DATE EXTRACTED : NA

MATRIX : MEDIUM SOIL

INSTRUMENT ID: VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG5920909	METHOD BLANK	09/09/92
4294-2	R1-V-4.0-4.5'	09/09/92



METHOD BLANK SUMMARY

WO # 4294

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/04/92

LAB SAMPLE ID:MSVG5920904

DATE EXTRACTED : NA

MATRIX :SOIL

INSTRUMENT ID:VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG5920904	METHOD BLANK	09/04/92
SSVG5920904A	SPIKE	09/04/92
SSVG5920904B	SPIKE DUP	09/04/92
4294-1	R1-A-8.5'-10'	09/04/92
4294-4	R1-V-18.5'-19'	09/04/92

METHOD BLANK SUMMARY

WO # 4294

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/08/92

LAB SAMPLE ID: MSVG3920908B

DATE EXTRACTED : NA

MATRIX : SOIL

INSTRUMENT ID: VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG3920908B	METHOD BLANK	09/08/92
4294-1	R1-A-8.5'-10'	09/08/92
4292-4	R1-V-18.5'-19'	09/08/92

ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL

COLUMN ID: VGC-5 DB624

DATE: 09/09/92

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene

MWVG5920909  
4294-2

METHOD BLANK  
R1-V-4.0'-4.5'

97  
62

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL

COLUMN ID: VGC-3 VOCOL

DATE: 09/08/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MWVG3920908B  
4294-2

METHOD BLANK  
R1-V-4.0'-4.5'

118  
52

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: SOIL

COLUMN ID: VGC-3 VOCOL

DATE: 09/08/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MSVG3920908B

METHOD BLANK

110

4294-1

R1-A-8.5'-10'

77

4294-4

R1-V-18.5'-19'

97

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: SOIL

COLUMN ID: VGC-5 DB624

DATE: 09/04/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MSVG5920904

SSVG5920904A

SSVG5920904B

4294-1

4294-4

METHOD BLANK

SPIKE

SPIKE DUP

R1-A-8.5'-10'

R1-V-18.5'-19'

99

105

101

73

88

**TOTAL RECOVERABLE PETROLEUM HYDROCARBONS  
DATA PACKAGE**

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley, CA 94710

ORGANIC ANALYTICAL REPORT

Work Order NO.: 4294

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical

Method: 418.1

Date Extracted: 09/15/92

QC Batch NO.: S92QCB023TPH

Date Analyzed: 09/22/92

Sample ID:	Client ID:	Result	Reporting Limit	Percent Moisture
4294-01	R1-A-8.5'-10'	5700	5	17.5
4294-02	R1-V-4.0'-4.5'	37	5	16.2
4294-04	R1-V-18.5'-19'	8	5	14.9
MSTPH920915	METHOD BLANK	ND	4	NA

NA\_ Not Analyzed  
ND\_ Not Detected

ANALYST:

*Alan S.*

GROUP LEADER:

*David*



## =====

ORGANIC QUALITY CONTROL RESULTS SUMMARY  
Blank Spike/Spike Duplicate

Work Order NO.: 4294

QC Sample NO.: SSTPH920915A &amp; B

Analytical Method: 418.1

Blank I.D.: MSTPH920915

Matrix: Soil

QC Batch NO.: S92QCB023TPH

Unit: mg/Kg

=====

Parameter	Date Analyzed	BR	SA	BS	PR	BSD	PR	RPD
TPH	09/22/92	0	165	176	107	172	104	2

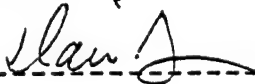
=====

BS-Blank Spike  
BSD-Blank Spike Duplicate  
SA-Spike Added  
BR\_Blank Result  
NA-Not Applicable  
NC-Not Calculated  
ND-Not Detected


$$RPD = ((BS - BSD) / ((BS + BSD) / 2)) * 100$$

$$PR = ((BS \text{ OR } BSD - BR) / SA) * 100$$

ANALYST:



QUALITY CONTROL:



**INORGANICS DATA PACKAGE**

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4294  
Matrix: SolidClient's ID: R1-A R1-V R1-V  
-8.5'-10' -4.0'-4.5' -18'

Sample Date: 08/27/92 08/26/92 08/26/92

% Moisture:

Lab ID: 4294.01 4294.02 4292.03

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND ND ND	SM 403(M)	50	mg/Kg CaCO3	09/10/92
Moisture	17.5 16.2 9.1	ASTM D2216	.1	% by wt	09/04/92
pH	5.2 4.9 5.4	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable  
ND- Not DetectedANALYST: Don MeatorGROUP LEADER: Walter S. Day

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4294  
Matrix: SolidClient's ID: Prep  
Blank

Sample Date:

% Moisture:

Lab ID: Prep Blank

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO <sub>3</sub>	09/10/92
Moisture	NA	ASTM D2216	.1	% by wt	09/04/92
pH	NA	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable

ND- Not Detected

ANALYST: Don SleatorGROUP LEADER: Will L. Long

## INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order: 4294 % Moisture: NA  
Lab ID of LCS: Matrix: Solid  
Alkalinity: 452.22 LCS Units: mg/Kg CaCO3

Parameter	Date Analyzed LCS	LCS Result	Conc Added	% Rec LCS	Advisory Limits	
					-- % Rec -- Low	High
Alkalinity	09/10/92	23000.00	23650.00	97	80	120

ANALYST: Don Gleason Date 9/29/92 REVIEWER: NWB Date 9/29/92  
File: M1QCLCSW

## INORGANIC QC SUMMARY - MS and MSD

Work Order: 4294

% Moisture: NA

	Alkalinity	Moisture	pH
Lab ID Spk/Dup:	Blank Spk	4286.01	4294.01
QC Batch:	452.22	451.51	453.34

Matrix: Solid

Units: mg/Kg CaCO<sub>3</sub> (Alk)  
% by wt. (Mois)  
pH Units (pH)

Parameter	Date Analyzed MS/Dup	-----Results-----			RPD	RPD QC Limit	-Conc Added-		Percent Recovered	
		Unspiked Sample	MS/Sample	MSD/Dup			MS	MSD	MS	MSD
Alkalinity	09/10/92	0.00	23000.00	23000.00	0	20	23650.00	23650.00	97	97
Moisture	09/04/92		15.34	18.00	16	20				
pH	09/15/92		5.21	5.49	5	20				

\* or N = Outside QC Limit:

QC Limits for % Rec: 75 - 125

ANALYST: Don Gleason Date 9/28/92 REVIEWER: MWB Date MWB  
File: M1QCNSWM

**METALS DATA PACKAGE**

METALS CASE NARRATIVE  
WORK ORDER NO.4294  
SOILS

The concentration of iron in sample MPA-18 was greater than four times the spike added to the MS and MSD samples. The LCS and duplicate LCS results for iron were checked, and the laboratory was found to be in control. All iron results in this batch are therefore reported unqualified based on matrix spike recovery.

The serial dilution sample result for iron did not agree with the undiluted result within 10%, and the diluted sample result was greater than ten times the iron MDL. All iron results in this batch are therefore flagged with "E".

Client ID's were abridged by the laboratory to facilitate computer entry of analytical data. The following should be used as a reference:

CLIENT ID

R1-A-8.5'-10'  
R1-V-4.0'-4.5'  
R1-V-18'

ABRIDGED ID

A-8.5'  
V-4.0'  
V-18'



## INORGANIC ANALYSES DATA SHEET

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_ Contract: AFCEE\_\_\_\_\_

A-8.5'

Lab Code: ESDL Case No.: 4294S SAS No.: SDG No.: A-3

Matrix (soil/water): SOIL\_ Lab Sample ID: 4294.01\_\_

Level (low/med):      LOW\_\_      Date Sampled : 08/27/92

% Solids:               \_82.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

Lab Name: E S BERKELEY LABORATORY\_ Contract: AFCEE

V-4.0'

Lab Code: ESBL Case No.: 4294S SAS No.: SDG No.: A-3

Matrix (soil/water): SOIL\_ Lab Sample ID: 4294.02\_\_

Level (low/med): LOW Date Sampled : 08/26/92

• Solids: 83.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

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\_\_\_\_\_

\_\_\_\_\_

**Comments:**

## INORGANIC ANALYSES DATA SHEET

V-18'

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_ Contract: AFCEE\_\_\_\_\_

Lab Code: ESBL\_\_\_\_\_ Case No.: 4294S SAS No.: \_\_\_\_\_ SDG No.: A-3\_\_\_\_\_

Matrix (soil/water): SOIL\_ Lab Sample ID: 4294.03\_\_

Level (low/med):      LOW\_\_      Date Sampled : 08/26/92

% Solids:                    \_90.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

PBLANK

Lab Code: ESBL Case No.: 4294S SAS No.: SDG No.: A-3

Lab Sample ID: PREP BLANK

Date Sampled : 09/16/92

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

**Comments:**

CLIENT SAMPLE ID

## SPIKE SAMPLE RECOVERY

MPA-1851

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_

Contract: AFCEE.

Lab Code: ESBL\_\_

Case No.: 4294S

SAS No. :

SDG No. : A-3\_

Matrix (soil/water): SOIL\_\_

Level (low/med): LOW\_\_

% Solids for Sample: \_94.7

Concentration Units (ug/L or mg/kg dry weight):MG/KG

[illegible]

**Comments:**

## SPIKE SAMPLE RECOVERY

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_

Contract: AFCEE

MPA-1852

Lab Code: ESBL\_\_

Case No. : 4294S

SAS No. :

SDG No.: A-3\_\_\_\_\_

Matrix (soil/water): SOIL\_\_

Level (low/med): LOW\_\_

Solids for Sample: \_94.7

Concentration Units (ug/L or mg/kg dry weight):MG/KG

[illegible]

**Comments:**

MATRIX SPIKE DUPLICATE

CLIENT SAMPLE ID

MPA-18SD

Lab Name: E S BERKELEY LABORATORY Contract: AFCEE

Lab Code: ESBL Case No.: 4294S SAS No.: SDG No.: A-3

Matrix (soil/water): SOIL\_ Level (low/med): \_LOW\_

% Solids for Sample: 94.7                      % Solids for Duplicate: 94.9

Concentration Units (ug/L or mg/kg dry weight):MG/KG

[illegible]

## BLANK SPIKE SAMPLE

Contract: AFCEE\_\_\_\_\_

SDG No.: A-3

Aqueous LCS Source: \_\_\_\_\_

FORM VII - IN





BLANK SPIKE DUPLICATE

LCSSD

Contract: AFCEE

Lab Code: ESBL

Case No.: 4294S

SAS No. : \_\_\_\_\_

SDG No. : A-3\_\_\_\_\_

Matrix (soil/water): SOIL\_

Level (low/med): LOW

Solids for Sample: 100.0

% Solids for Duplicate: 100.0

Concentration Units (ug/L or mg/kg as received): MG/KG

[illegible]

## ICP SERIAL DILUTION

MPA-18L

Lab Name: E S BERKELEY LABORATORY Contract: AFCEE          

Lab Code: ESBL\_\_\_\_\_ Case No.: 4294S\_ SAS No.: \_\_\_\_\_ SDG No.: A-3\_\_\_\_\_

Matrix (soil/water): SOIL\_ Level (low/med): LOW\_

Concentration Units: ug/L

[illegible]

Furnace AA ID Number : \_\_\_\_\_ (ug/L in 1.00g to 100ml digestate)

[illegible]

Comments:



## ANALYSIS RUN LOG

Lab Name: E\_S\_BERKELEY\_LABORATORY\_

Contract: AFCEE\_\_\_\_\_

Lab Code: ESBL\_ Case No.: 4294S\_

SAS No.: \_\_\_\_\_ SDG No.: A-3\_

Instrument ID Number: TJA 61 M\_

Method: P\_

Start Date: 09/17/92

End Date: 09/17/92

EPA Sample No.	D/F	Time	% R	Analytes																	
				F																	
STD1	1.00	1423		X																	
STD2	1.00	1427		X																	
STD3	1.00	1432		X																	
STD4	1.00	1437		X																	
ICV	1.00	1441		X																	
ICB	1.00	1446		X																	
ICSA	1.00	1451		X																	
ICSAB	1.00	1455		X																	
CRI	1.00	1500																			
PBLANK	1.00	1504		X																	
ZZZZZZ	1.00	1509																			
LCSS	1.00	1514		X																	
LCSSD	1.00	1518		X																	
A-8.5'	1.00	1523		X																	
V-4.0'	1.00	1527		X																	
V-18'	1.00	1532		X																	
CCV	1.00	1537		X																	
CCB	1.00	1541		X																	
V-7'3"	1.00	1546		X																	
A-5	1.00	1551		X																	
A-3	1.00	1555		X																	
VW-8	1.00	1600		X																	
MPA-07	1.00	1604		X																	
MPA-18	1.00	1609		X																	
MPA-18S1	1.00	1614		X																	
MPA-18S2	1.00	1618		X																	
MPA-18L	1.00	1623		X																	
CCV	1.00	1627		X																	
CCB	1.00	1632		X																	
MPB-18	1.00	1637		X																	
MPB-06	1.00	1641		X																	
MPC-06	1.00	1646		X																	



TOTAL KJELDAHL NITROGEN

TOTAL PHOSPHATE

SOIL CLASSIFICATION

DATA PACKAGE





# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294  
Sample Descript: Soil  
Analysis for: Total Phosphorous  
First Sample #: 209-0160

Sampled: 8/26-27/92  
Received: Sep 2, 1992  
Analyzed: Sep 16, 1992  
Reported: Sep 21, 1992

## LABORATORY ANALYSIS FOR: Total Phosphorous

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0160	R1-A-8.5'-10'	10	79
209-0161	R1-V-4.0'-4.5'	10	110
209-0162	R1-V-18'	10	64
-	Method Blank	10	N.D.

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

 9/28/92  
ESBL PROJECT MANAGER DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

Please Note:

Analysis results reported on a dry-weight basis.

2090160.ENG <4>



# SEQUOIA ANALYTICAL

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(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294  
Sample Descript: Soil  
Analysis for: Total Kjeldahl Nitrogen  
First Sample #: 209-0160

Sampled: 8/26-27/92  
Received: Sep 2, 1992  
Analyzed: Sep 3, 1992  
Reported: Sep 21, 1992

## LABORATORY ANALYSIS FOR: Total Kjeldahl Nitrogen

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0160	R1-A-8.5'-10'	20	68
209-0161	R1-V-4.0'-4.5'	20	110
209-0162	R1-V-18'	20	92
-	Method Blank	20	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

Please Note:

Analysis results reported on a dry-weight basis.

2090160.ENG <5>



# SEQUOIA ANALYTICAL

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(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294

QC Sample Group: 209-0160-62

Reported: Sep 21, 1992

## QUALITY CONTROL DATA REPORT

ANALYTE	Total Kjeldahl	
	Nitrogen	Total Phosphorous

Method:	EPA351.4	EPA365.3
Analyst:	G. Kern	K. Follett
Reporting Units:	mg/kg	mg/kg
Date Analyzed:	Sep 3, 1992	Jul 16, 1992
QC Sample #:	209-0162	209-0841

Sample Conc.: 84 40

Spike Conc.  
Added: 4000 100

Conc. Matrix  
Spike: 4600 120

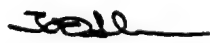
Matrix Spike  
% Recovery: 113 80

Conc. Matrix  
Spike Dup.: 4600 130

Matrix Spike  
Duplicate  
% Recovery: 113 90

Relative  
% Difference: 0.0 8.0

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

% Recovery:	$\frac{\text{Conc. of M.S.} - \text{Conc. of Sample}}{\text{Spike Conc. Added}} \times 100$
Relative % Difference:	$\frac{\text{Conc. of M.S.} - \text{Conc. of M.S.D.}}{(\text{Conc. of M.S.} + \text{Conc. of M.S.D.}) / 2} \times 100$

2090160.ENG <6>



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Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294  
Sample Descript: Soil, R1-A-8.5'-10'  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0160

Sampled: Aug 27, 1992  
Received: Sep 2, 1992  
Analyzed: Sep 9, 1992  
Reported: Sep 21, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:
- (B) WEIGHT RETAINED IN NO. 10 SIEVE:
- (C) % PASSING NO. 10 SIEVE:

229.98g
0.75g
99.67

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½in.	0.0	0.0	0.0	100
3/8in.	0.0	0.0	0.0	100
No. 4	0.0	0.0	0.0	100
No. 10	0.75g	0.33	0.33	99.67
PAN	0.0			
TOTAL	0.75g			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	21	22	18	13.3	0.035	28
5	21	20	16	13.7	0.022	25
10	21	19	15	13.8	0.016	23
15	21	18	14	14.0	0.013	22
25	21	18	14	14.0	0.010	22
40	21	18	14	14.0	0.0080	22
60	21	17	13	14.2	0.0067	20
90	21	17	13	14.2	0.0054	20
120	21	17	13	14.2	0.0046	20
1440	21	16	12	14.3	0.0013	19

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
 HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
 SPECIFIC GRAVITY (ASSUMED):  
 DISPERSING AGENT CORRECTION FACTOR (E):  
 MENISCUS CORRECTION FACTOR (F):  
 TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.988
2.65
3
1
0.01348

#### FORMULAS:

$R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

SEQUOIA ANALYTICAL

  
 Tod Granicher  
 Project Manager

2090160.ENG <1>



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294  
Sample Descript: Soil, R1-V-4.0'-4.5'  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0161

Sampled: Aug 26, 1992  
Received: Sep 2, 1992  
Analyzed: Sep 9, 1992  
Reported: Sep 21, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:
- (B) WEIGHT RETAINED IN NO. 10 SIEVE:
- (C) % PASSING NO. 10 SIEVE:

155.43g
0.50g
99.68

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	0.0	0.0	0.0	100
No. 10	0.50	0.32	0.32	99.68
PAN	0.0			
TOTAL	0.50			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	21	29	25	12.2	0.033	38
5	21	28	25	12.4	0.021	37
10	21	27	23	12.5	0.015	35
15	21	27	23	12.5	0.012	35
25	21	27	23	12.5	0.0095	35
40	21	26	22	12.7	0.0076	34
60	21	26	22	12.7	0.0062	34
90	21	25	21	12.9	0.0051	32
120	21	24	20	13.0	0.0044	31
1440	21	24	20	13.0	0.0013	31

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
 HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
 SPECIFIC GRAVITY (ASSUMED):  
 DISPERSING AGENT CORRECTION FACTOR (E):  
 MENISCUS CORRECTION FACTOR (F):  
 TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.996
2.65
3
1
0.01348

#### FORMULAS:

$R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

SEQUOIA ANALYTICAL

  
 Tod Granicher  
 Project Manager



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4294  
Sample Descript: Soil, R1-V-18'  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0162

Sampled: Aug 26, 1992  
Received: Sep 2, 1992  
Analyzed: Sep 9, 1992  
Reported: Sep 21, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:  
(B) WEIGHT RETAINED IN NO. 10 SIEVE:  
(C) % PASSING NO. 10 SIEVE:

185.38g
38.93g
79.00

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	5.49	2.96	2.96	97.04
No. 10	33.44	18.04	21.00	79.00
PAN	0.0			
TOTAL	38.93			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	21	22	18	13.3	0.035	28
5	21	20	16	13.7	0.022	25
10	21	19	15	13.8	0.016	23
15	21	19	15	13.8	0.013	22
25	21	19	15	13.8	0.010	22
40	21	18	14	14.0	0.0080	22
60	21	18	14	14.0	0.0065	20
90	21	18	14	14.0	0.0053	20
120	21	17	13	14.2	0.0046	20
1440	21	17	13	14.2	0.0013	19

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
SPECIFIC GRAVITY (ASSUMED):  
DISPERSING AGENT CORRECTION FACTOR (E):  
MENISCUS CORRECTION FACTOR (F):  
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.991
2.65
3
1
0.01348

#### FORMULAS:

$R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

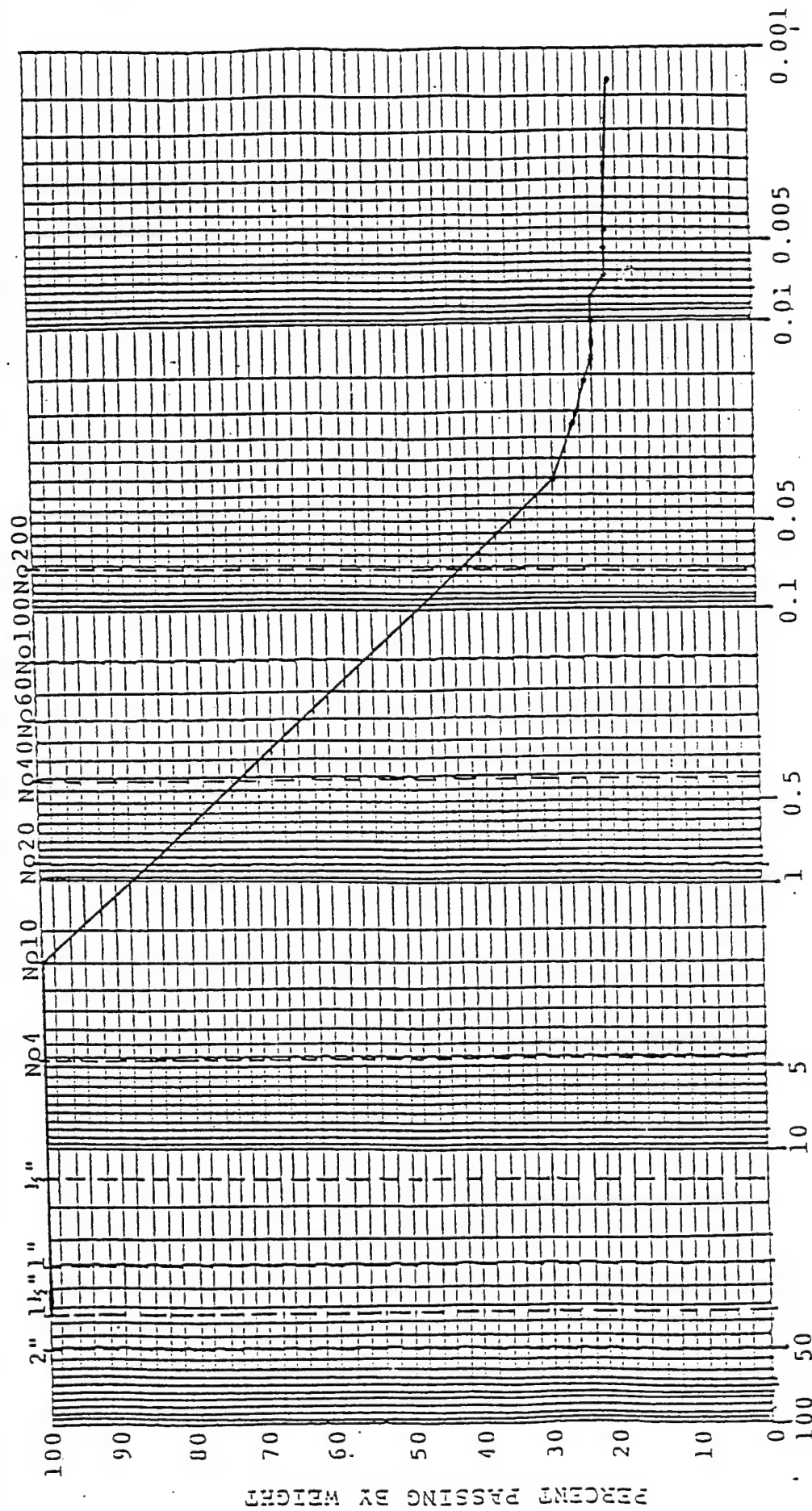
SEQUOIA ANALYTICAL

Tod Granicher  
Project Manager

2090160.ENG <3>

LABORATORY NUMBER: 209-0160

U.S. STANDARD SIEVE SIZES



GRAIN DIAMETER IN MILLIMETERS

GRAIN DIAMETER IN MILLIMETERS						
COBBLES	GRAVEL		SAND			FINES
	COARSE	FINE	COARSE	MEDIUM	FINE	

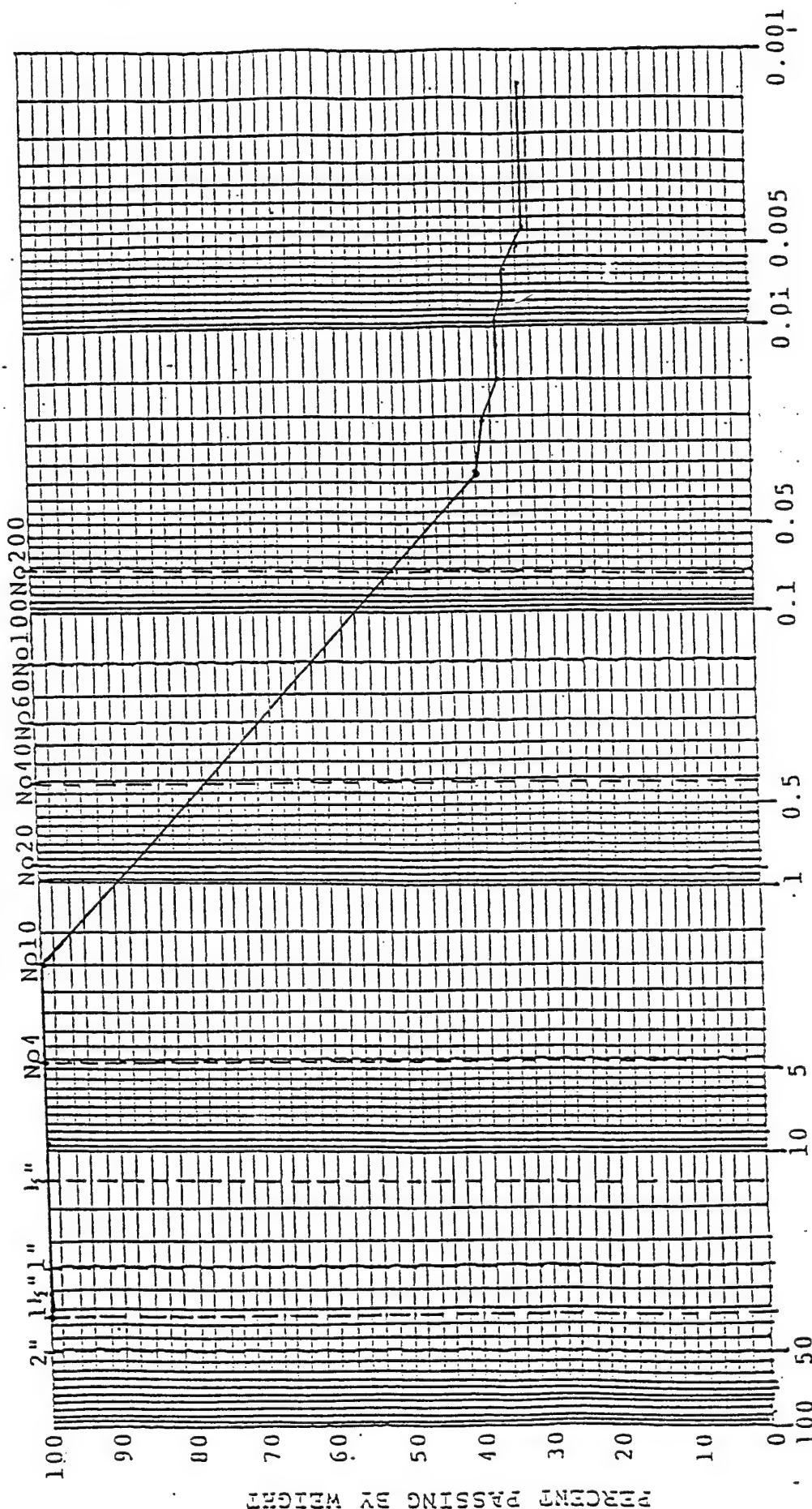


SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0161

U.S. STANDARD SIEVE SIZES

GRAVEL	0%
SAND	49%
SILT	20%
CLAY	31%



GRAIN DIAMETER IN MILLIMETERS

COBBLES	GRAVEL	SAND	FINES	SILT SIZES			CLAY SIZES
				FINE			
				COARSE	MEDIUM		
	COARSE	FINE	COARSE	MEDIUM			

ROBBIES

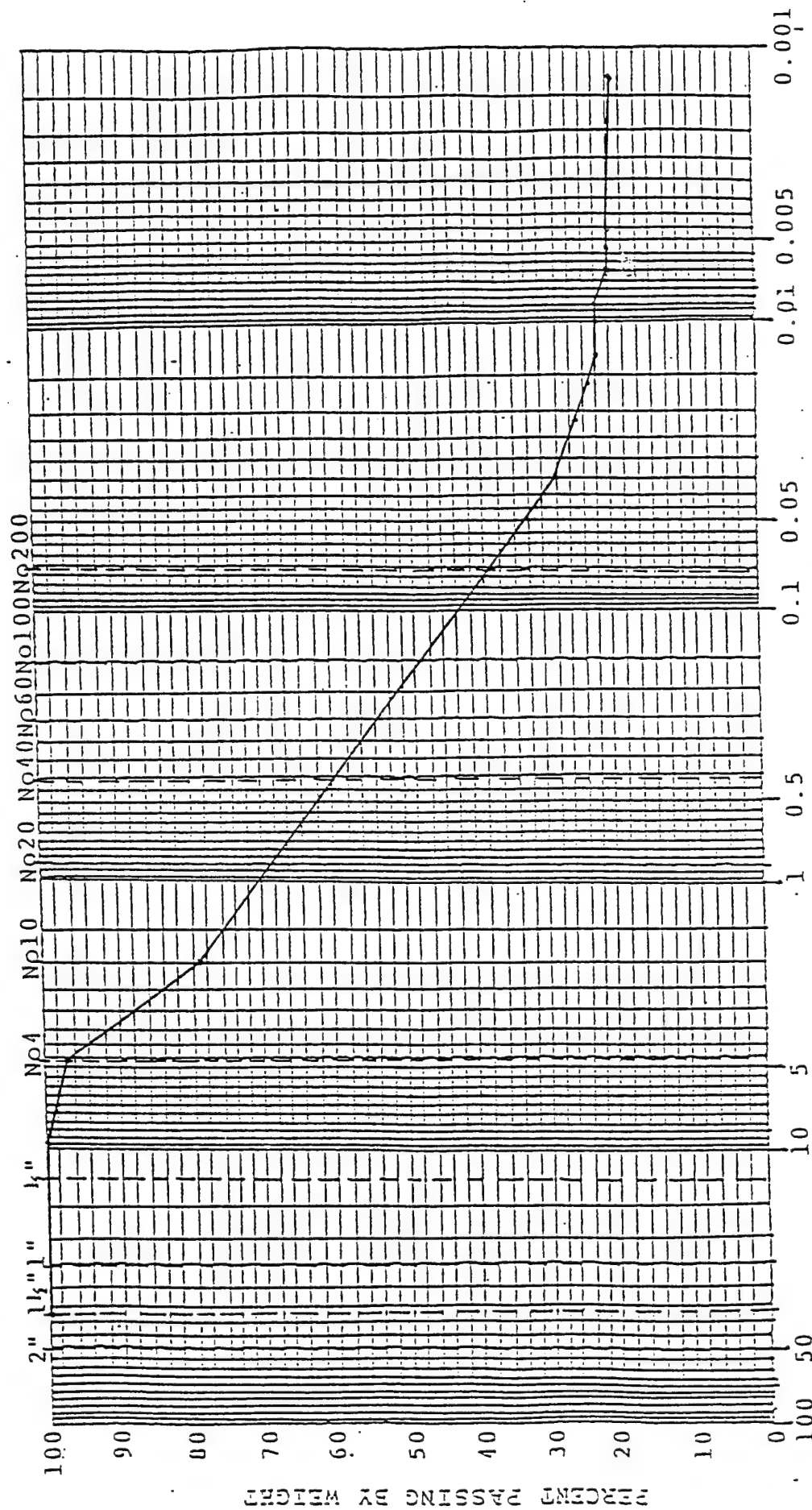


SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0162

U.S. STANDARD SIEVE SIZES

	40%
SAND	
SILT	37%
CLAY	20%



GRAIN DIAMETER IN MILLIMETERS

COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
GRAVEL			SAND		FINES	

## CHAIN OF CUSTODY RECORD

[illegible]



## Columbus Laboratories

## CHAIN OF CUSTODY RECORD

Form No.

[illegible]

**APPENDIX B**

**SITE UST 173 SOIL GAS PERMEABILITY DATA**

TABLE B-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R1-MPA

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	6'10"	14'3"	21'10"		6'10"	14'3"	21'10"
0	0	0.01	0.01	20	0	0.22	0.25
1	0	0.14	0.23	23	0	0.215	0.25
2	0	0.145	0.235	26	0	0.22	0.25
3	0	0.155	0.235	29	0	0.215	0.25
4	0	0.165	0.235	32	0	0.22	0.25
5	0.005	0.170	0.24	37	0	0.22	0.25
6	0.005	0.180	0.24	42	0	0.205	0.25
7	0.005	0.185	0.24	47	0	0.235	0.25
8	0	0.19	0.239	57	0	0.235	0.25
9	0	0.185	0.245	67	0	0.25	0.30
10	0	0.185	0.245	77	0	0.25	0.35
12	0	0.190	0.25	87	0	0.25	0.35
14	0	0.190	0.25	107	0	0.25	0.35
16	0	0.195	0.25	127	0	0.25	0.35
18	0	0.20	0.25	147	0	0.25	0.35

**TABLE B-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R1-MPB**

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	8'	15'	23'		8'	15'	23'
0	<0	<0	0.02	23	0.01	0.19	0.20
1	0.005	0.1	0.12	26	0.01	0.19	0.20
2	0.01	0.12	0.135	29	0.01	0.185	0.19
3	0.015	0.13	0.14	32	0.005	0.175	0.19
4	0.025	0.13	0.145	38	0.005	0.18	0.195
5	0.02	0.135	0.155	48	0.03	0.195	0.21
6	0.025	0.14	0.155	53	0.025	0.20	0.22
7	0.025	0.14	0.155	58	0.02	0.2	0.22
8	0.025	0.145	0.16	68	0.03	0.21	0.235
9	0.25	0.14	0.16	78	0.14	0.25	0.30
10	0.025	0.14	0.16	88	0.10	0.25	0.30
12	0.02	0.16	0.17	98	0.04	0.25	0.27
14	0.015	0.16	0.175	108	<0	0.24	0.25
16	0.01	0.165	0.185	118	<0	0.22	0.30
18	0.015	0.17	0.19	138	<0	0.22	0.30
20	0.01	0.18	0.20	148	<0	0.21	0.30

TABLE B-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R1-MPC

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	8'	15'	23'		8'	15'	23'
0	0	0.02	0.02	26	0.013	0.165	0.165
1	0	0.095	0.10	29	0.015	0.165	0.165
2	0	0.11	0.11	32	0.013	0.173	0.170
3	0.005	0.115	0.119	35	0.013	0.173	0.175
4	0.007	0.12	0.12	40	0.013	0.167	0.163
5	0.01	0.135	0.135	45	0.015	0.185	0.185
6	0.01	0.145	0.145	50	0.015	0.193	0.193
7	0.01	0.137	0.140	55	0.010	0.193	0.193
8	0.01	0.139	0.140	60	0.017	0.203	0.196
9	0.01	0.140	0.140	70	0.020	0.200	0.196
10	0.01	0.147	0.150	80	0.020	0.220	0.220
12	0.01	0.155	0.155	90	0.020	0.227	0.227
14	0.01	0.155	0.157	100	0.017	0.225	0.222
16	0.013	0.163	0.165	110	0.015	0.222	0.222
18	0.013	0.165	0.167	120	0.025	0.245	0.243
20	0.015	0.180	0.183	140	0.02	0.220	0.220
23	0.013	0.183	0.183				

**APPENDIX C**

**SITE UST 173 IN SITU RESPIRATION TEST DATA**



**APPENDIX C**

**SITE UST 173 IN SITU RESPIRATION TEST DATA**

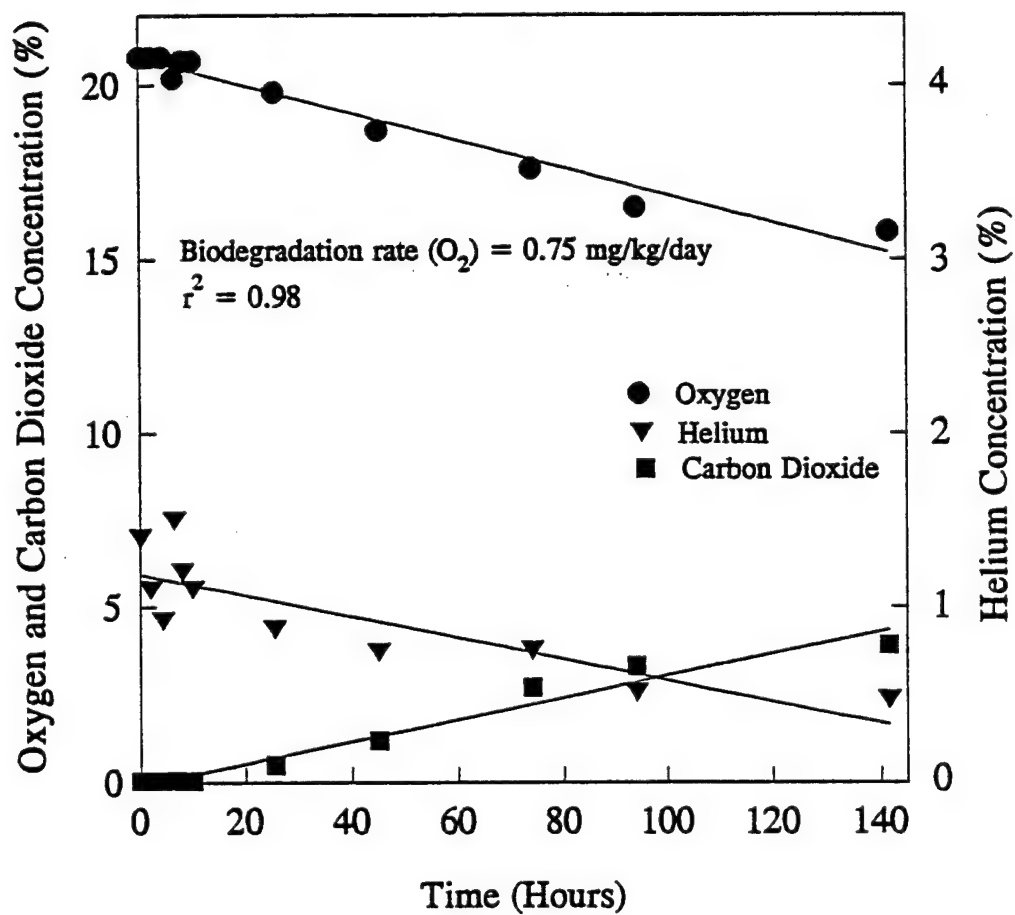


Figure C-1. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R1-MPA-14'3"

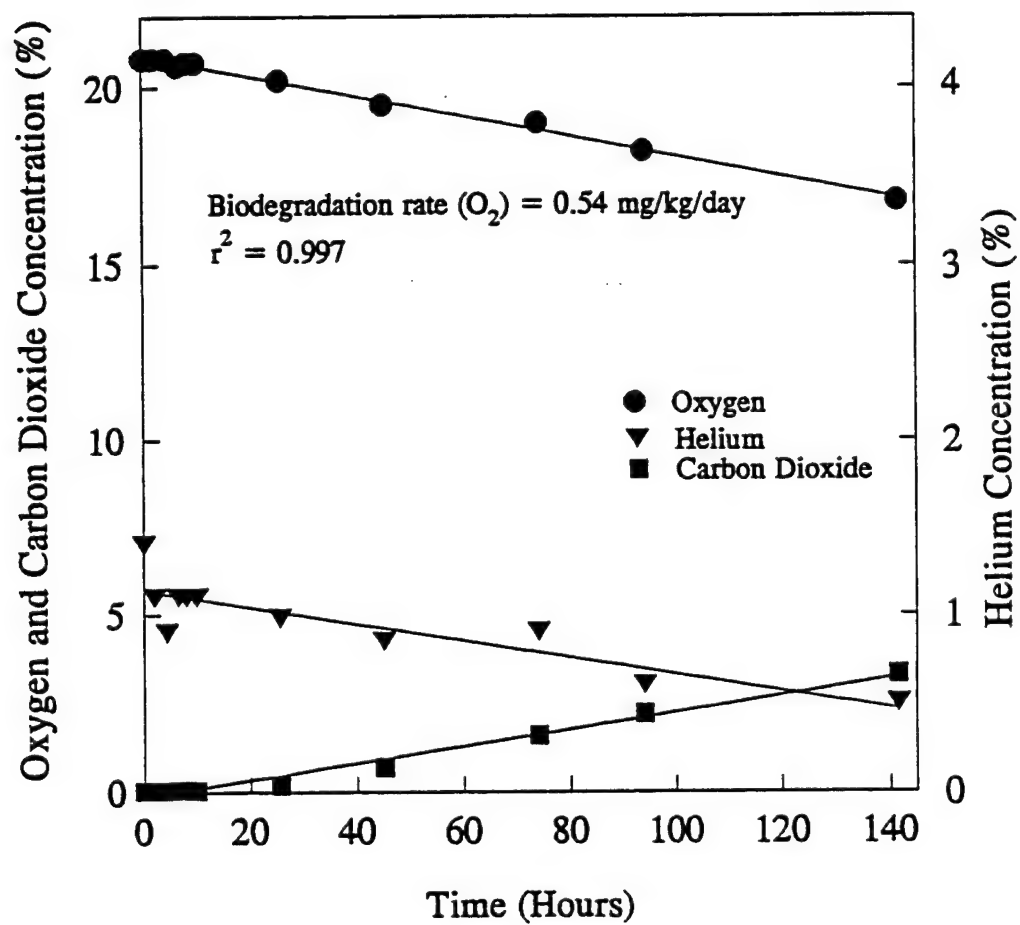


Figure C-2. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R1-MPA-21'10"

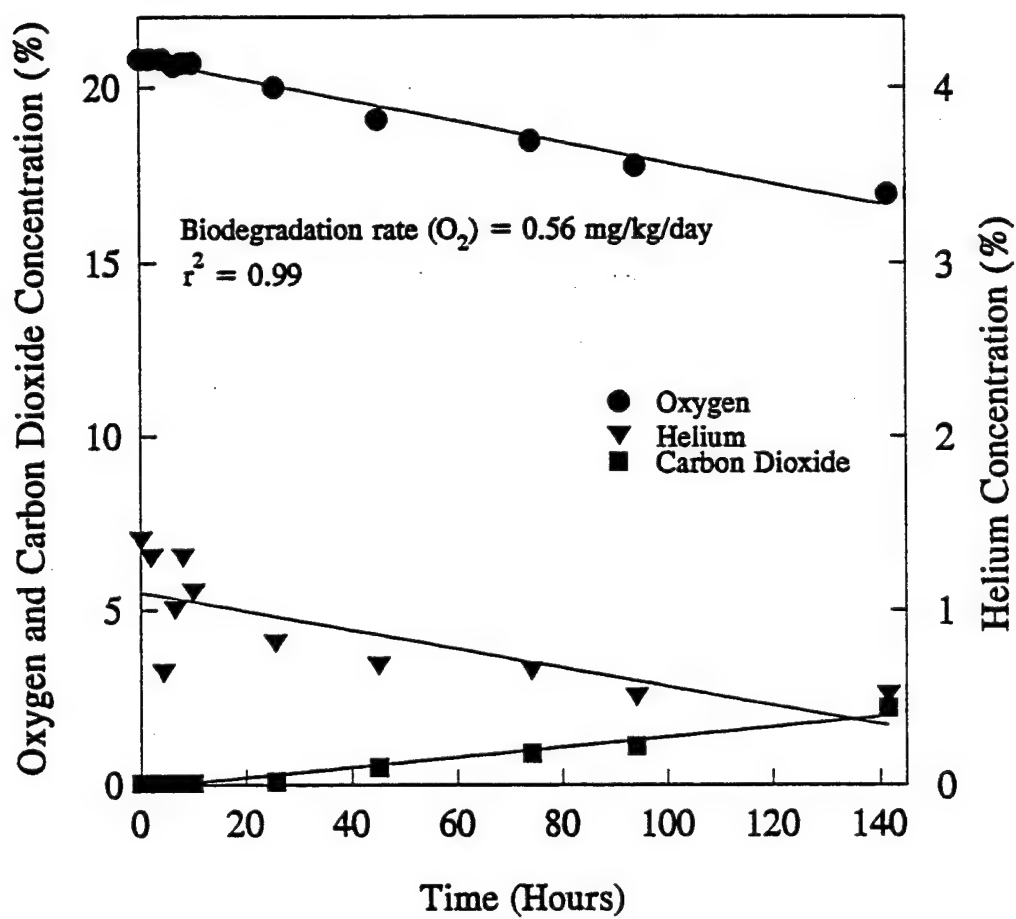


Figure C-3. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R1-MPC-15'

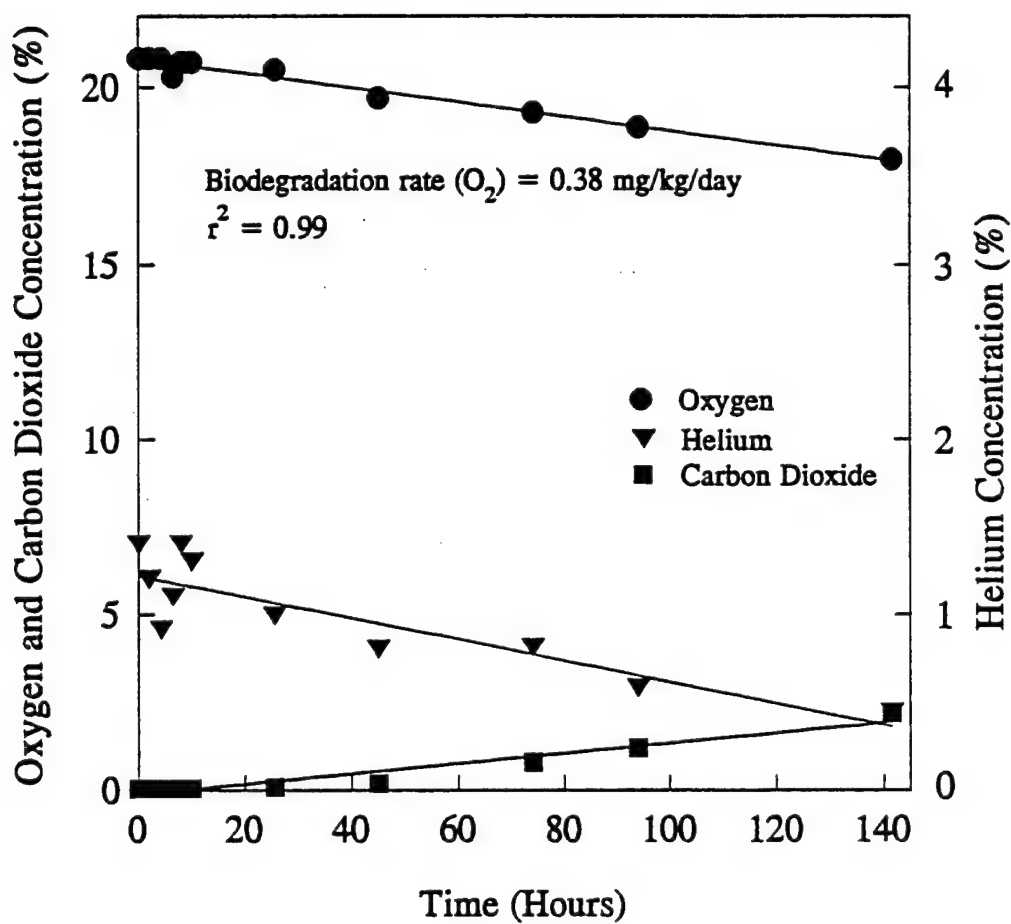


Figure C-4. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R1-MPC-23'

**APPENDIX D**

**ANALYTICAL REPORT FOR SITE SS-10**

**@ AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

**WORK ORDER #: 9209019****Work Order Summary**

<b>CLIENT:</b>	Mr. Jeff Kittel Battelle 505 King Ave. Columbus, OH 43201	<b>BILL TO:</b>	Accounts Payable Engineering Science 1700 Broadway Ste. 900 Denver, CO 80290
<b>PHONE:</b>	614-424-6122	<b>INVOICE #</b>	8436
<b>FAX:</b>	614-424-3667	<b>P.O. #</b>	
<b>DATE RECEIVED:</b>	9/4/92	<b>AMOUNT:</b>	\$520.00
<b>DATE REPORTED:</b>	9/14/92	<b>PROJECT #</b>	DE268.03

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>Receipt VAC./Press.</u>	<u>PRICE</u>
01A	Ambient	TO-3	1.5 "Hg	\$120.00
02A	R2-C-8	TO-3	0.5 "Hg	\$120.00
03A	R2-A-5'	TO-3	0 "Hg	\$120.00
04A	R2-VW	TO-3	0.5 "Hg	\$120.00

Misc. Charges 1 Liter SUMMA Canister Preparation (4) @ \$10.00 each. \$40.00

REVIEWED BY: Craig C. BrownDATE: 9/15/92CERTIFIED BY: Judith L. FreemanDATE: 9/15/92

11325 SUNRISE GOLD CIRCLE, SUITE E • RANCHO CORDOVA, CA 95742  
(916) 638-9892 • FAX (916) 638-9917

**AIR TOXICS LTD.**

SAMPLE NAME: Ambient

ID#: 9209019-01A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090809	Date of Collection: 9/3/92	
Dil. Factor:		2.1	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	Not Detected	Not Detected
Toluene	0.002	0.008	Not Detected	Not Detected
Total Xylenes	0.002	0.009	Not Detected	Not Detected
Ethyl Benzene	0.002	0.009	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090809	Date of Collection: 9/3/92	
Dil. Factor:		2.1	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.021	0.084	0.55	2.2

\*TPH referenced to Jet Fuel (MW=156)



**AIR TOXICS LTD.**

SAMPLE NAME: R2-C-8

ID#: 9209019-02A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090810	Date of Collection: 9/3/92	
Dil. Factor:		5200	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	5.2	16	330	1000
Toluene	5.2	16	120	370
Total Xylenes	5.2	16	100	310
Ethyl Benzene	5.2	16	22	69

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090810	Date of Collection: 9/3/92	
Dil. Factor:		5200	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	52	210	72000	290000

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R2-A-5'

ID#: 9209019-03A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:	6090811	Date of Collection:	9/3/92	
Dil Factor:	10000	Date of Analysis:	9/8/92	
	MDL	MDL	Amount	Amount
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)
Benzene	10	31	220	690
Toluene	10	37	87	320
Total Xylenes	10	42	72	310
Ethyl Benzene	10	42	14	59

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:	6090811	Date of Collection:	9/3/92	
Dil. Factor:	10000	Date of Analysis:	9/8/92	
	MDL	MDL	Amount	Amount
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)
TPH*	100	400	50000	200000

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R2-VW

ID#: 9209019-04A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090812	Date of Collection: 9/3/92	
Dil. Factor:		10000	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	10	31	260	810
Toluene	10	37	120	440
Total Xylenes	10	42	81	340
Ethyl Benzene	10	42	11	47

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090812	Date of Collection: 9/3/92	
Dil. Factor:		10000	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	100	400	42000	170000

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: Lab Blank

ID#: 9209019-05A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090808	Date of Collection: NA	
Dil. Factor:		1.0	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090808	Date of Collection: NA	
Dil. Factor:		1.0	Date of Analysis: 9/8/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.010	0.040	Not Detected	Not Detected

\*TPH referenced to Jet Fuel (MW=156)



## Columbus Laboratories

**CHAIN OF CUSTODY RECORD**

Form No.

[illegible]

**@ AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

**WORK ORDER #: 9209004**

## Work Order Summary

**CLIENT:** Mr. Jeff Kittel **BILL TO:** Accounts Payable  
Battelle Engineering Science  
505 King Ave. 1700 Broadway Ste. 900  
Columbus, OH 43201 Denver, CO 80290

**PHONE:** 614-424-6122 **INVOICE #** 8415  
**FAX:** 614-424-3667 **P.O. #** DE268.03  
**DATE RECEIVED:** 9/1/92 **AMOUNT:** \$565.98  
**DATE REPORTED:** 9/8/92 **PROJECT #** E-S JOB DE268.03

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>Receipt</u> <u>VAC./Press.</u>	<u>PRICE</u>
01A	R1-V	TO-3	0.5 "Hg	\$120.00
02A	R1-C	TO-3	1.5 "Hg	\$120.00
03A	Ambient -R1	TO-3	0 "Hg	\$120.00
04A	R1-A	TO-3	1.0 "Hg	\$120.00
05A	Lab Blank	TO-3	NA	NC

Misc. Charges 1 Liter SUMMA Canister Preparation (4) @ \$10.00 each. \$40.00  
Shipping (8/27/92) \$45.98

REVIEWED BY: [Signature]DATE: 9/9/92CERTIFIED BY: [Signature]DATE: 9/9/92

11325 SUNRISE GOLD CIRCLE, SUITE E • RANCHO CORDOVA, CA 95742

(916) 638-9892 • FAX (916) 638-9917

**AIR TOXICS LTD.**

SAMPLE NAME: R1-V

ID#: 9209004-01A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name: 6090305		Date of Collection: 8/30/92		
Dil. Factor: 4.1		Date of Analysis: 9/3/92		
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.004	0.013	Not Detected	Not Detected
Toluene	0.004	0.015	0.025	0.092
Total Xylenes	0.004	0.017	2.2	9.3
Ethyl Benzene	0.004	0.017	0.31	1.3

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name: 6090305		Date of Collection: 8/30/92		
Dil. Factor: 4.1		Date of Analysis: 9/3/92		
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.041	0.16	300	1200

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R1-C

ID#: 9209004-02A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090306	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.002	0.007	Not Detected	Not Detected	
Toluene	0.002	0.007	0.006	0.019	
Total Xylenes	0.002	0.007	0.098	0.31	
Ethyl Benzene	0.002	0.007	0.14	0.44	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090306	Date of Collection:		8/30/92
Dil. Factor:		2.1	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.021	0.084	27	110	

\*TPH referenced to Jet Fuel (MW=156)



**AIR TOXICS LTD.**

SAMPLE NAME: Ambient -R1

ID#: 9209004-03A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090308	Date of Collection:		8/30/92
Dil. Factor:		2.0	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.002	0.006	Not Detected	Not Detected	
Toluene	0.002	0.007	Not Detected	Not Detected	
Total Xylenes	0.002	0.008	Not Detected	Not Detected	
Ethyl Benzene	0.002	0.008	Not Detected	Not Detected	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090308	Date of Collection:		8/30/92
Dil. Factor:		2.0	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.020	0.080	0.20	0.80	

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: R1-A

ID#: 9209004-04A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

<b>File Name:</b>		<b>6090309</b>	<b>Date of Collection:</b>		<b>8/30/92</b>
<b>Dil. Factor:</b>		<b>2.1</b>	<b>Date of Analysis:</b>		<b>9/3/92</b>
<b>Compound</b>	<b>MDL (ppmv)</b>	<b>MDL (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>	
Benzene	0.002	0.007	Not Detected	Not Detected	
Toluene	0.002	0.008	0.052	0.19	
Total Xylenes	0.002	0.009	0.81	3.4	
Ethyl Benzene	0.002	0.009	0.055	0.23	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

<b>File Name:</b>		<b>6090309</b>	<b>Date of Collection:</b>		<b>8/30/92</b>
<b>Dil. Factor:</b>		<b>2.1</b>	<b>Date of Analysis:</b>		<b>9/3/92</b>
<b>Compound</b>	<b>MDL (ppmv)</b>	<b>MDL (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>	
TPH*	0.021	0.084	290	1200	

\*TPH referenced to Jet Fuel (MW=156)

**AIR TOXICS LTD.**

SAMPLE NAME: Lab Blank

ID#: 9209004-05A

**EPA Method TO-3**  
(Aromatic Volatile Organics in Air)**BTXE BY GC/PID**

File Name:		6090303	Date of Collection:		NA
Dil. Factor:		1.0	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.001	0.003	Not Detected	Not Detected	
Toluene	0.001	0.004	Not Detected	Not Detected	
Total Xylenes	0.001	0.004	Not Detected	Not Detected	
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected	

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

File Name:		6090303	Date of Collection:		NA
Dil. Factor:		1.0	Date of Analysis:		9/3/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.010	0.040	Not Detected	Not Detected	

\*TPH referenced to Jet Fuel (MW=156)

## CHAIN OF CUSTODY RECORD

Form No.

[illegible]



ENGINEERING-SCIENCE, INC.

BERKELEY LABORATORY  
600 BANCROFT WAY  
BERKELEY, CA 94710  
Tel: (415) 841-7353

Report Date: October 15, 1992

Work Order No.: 4310

Client: Jeff Kittel  
Battelle  
505 King Ave  
Columbus, OH 43201

Date of Sample Receipt: 09/04/92

Your soil samples identified as:

R2-V-7'-3"

R2-A-5-5.5'

R2-A-3-3.5'

were analyzed for BTEX by EPA Method 8020, pH, alkalinity, iron, total kjeldahl nitrogen, soil moisture, TRPH by EPA Method 418.1, soil classification by ASTM D422 and total phosphorus.

The analytical reports for the samples listed above are attached.

**GC VOLATILES DATA PACKAGE**

---

GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

---

Work Order NO.:4310

% Moisture: 8.18

Client ID:R2-V-7'3"

Matrix:SOIL

Laboratory ID:4310-1

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 20

Date Analyzed:09/09/92

Date Confirmed:09/14/92

---

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	1300.0
Ethyl Benzene	24000.0	39000.0	1100.0
Toluene	68000.0	59000.0	1500.0
Xylenes (total)	170000.0	220000.0	2000.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AB*GROUP LEADER: *[Signature]*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture: 8.18

Client ID:R2-A-5-5.5'

Matrix:SOIL

Laboratory ID:4310-2

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 4

Date Analyzed:09/09/92  
Date Confirmed:09/14/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	260.0
Ethyl Benzene	480.0	2000.0	220.0
Toluene	870.0	700.0	300.0
Xylenes (total)	3600.0	6800.0	390.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AS*GROUP LEADER: *Robert*



-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture: 11.82

Client ID:R2-A-3-3.5'

Matrix:SOIL

Laboratory ID:4310-3

Level:LOW

Unit:ug/KG

Dilution Factor: 5

Date Analyzed:09/10/92

Date Confirmed:09/14/92  
-----

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	80.0	53.0	3.4
Ethyl Benzene	83.0	54.0	2.8
Toluene	100.0	98.0	4.0
Xylenes (total)	480.0	540.0	5.1

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AS*GROUP LEADER: *Russell*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MSVG3920910

Level:LOW

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/10/92  
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AS*GROUP LEADER: *[Signature]*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MSVG5920914

Level:LOW

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/14/92

Date Confirmed:

-----

Compound	Primary Result	Confirmatory Result	Reporting Limit
-----			
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: AB

GROUP LEADER: 

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MWVG3920909

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/09/92  
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AB*GROUP LEADER: *hual*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4310

% Moisture:NA

Client ID:METHOD BLANK

Matrix:SOIL

Laboratory ID:MWVG2920914

Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1

Date Analyzed:09/14/92  
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AB*GROUP LEADER: *kwon*

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: LOW SOIL

COLUMN ID: VGC-3 VOCOL

DATE: 09/10/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MSVG3920910  
SSVG3920910A  
SSVG3920910B  
4310-3

METHOD BLANK  
SPIKE  
SPIKE DUP  
R2-A-3-3.5'

111  
110  
102  
94

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTX AROMATIC COMPOUNDS

MATRIX: LOW SOIL

COLUMN ID: VGC-5 DB624

DATE: 09/14/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MSVG5920914

METHOD BLANK

92

SSVG5920914A

SPIKE

91

SSVG5920914B

SPIKE DUP

92

4310-3

R2-A-3-3.5'

144

ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL

COLUMN ID: VGC-3 VOCOL

DATE: 09/09/92

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene

MWVG3920909

METHOD BLANK

78

SWVG3920909A

SPIKE

98

SWVG3920909B

SPIKE DUP

99

4310-1

R2-V-7'3"

71

4310-2

R2-A-5-5.5'

98



-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

GC ANALYTICAL REPORT  
ANALYTICAL REPORT  
BTX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL

COLUMN ID: VGC-2 DB624

DATE: 09/14/92  
-----

LABORATORY NO.

CLIENT ID

a-a-a-TriFluoro  
Toluene  
-----

MWVG2920914  
4310-1  
4310-2

METHOD BLANK  
R2-V-7'3"  
R2-A-5-5.5'

98  
140  
118

METHOD BLANK SUMMARY

WO # 4210<sup>3</sup>

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/10/92

LAB SAMPLE ID: MSVG3920910

DATE EXTRACTED : NA

MATRIX : SOIL

INSTRUMENT ID: VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG3920910	METHOD BLANK	09/10/92
SSVG3920910A	SPIKE	09/10/92
SSVG3920910B	SPIKE DUPLICATE	09/10/92
4310-3	R2-A-3-3.5'	09/10/92

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/14/92

LAB SAMPLE ID:MSVG5920914

DATE EXTRACTED : NA

MATRIX :SOIL

INSTRUMENT ID:VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG5920914	METHOD BLANK	09/14/92
SSVG5920914A	SPIKE	09/14/92
SSVG5920914B	SPIKE DUPLICATE	09/14/92
4310-3	R2-A-3-3.5'	09/14/92

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/10/92 <sup>09 TP 10/15</sup>

LAB SAMPLE ID: MWVG3920909

DATE EXTRACTED : NA

MATRIX : MEDIUM SOIL

INSTRUMENT ID: VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG3920909	METHOD BLANK	09/09/92
SWVG3920909A	SPIKE	09/09/92
SWVG3920909B	SPIKE DUP	09/09/92
4310-1	R2-V-7'3"	09/09/92
4310-2	R2-V-5-5.5'	09/09/92

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC.

DATE ANALYZED : 09/14/92

LAB SAMPLE ID: MWVG2920914

DATE EXTRACTED : NA

MATRIX : MEDIUM SOIL

INSTRUMENT ID: VGC-2

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG2920914	METHOD BLANK	09/14/92
4310-1	R2-V-7'-3"	09/14/92
4310-2	R2-A-5-5.5'	09/14/92

**TOTAL RECOVERABLE PETROLEUM HYDROCARBONS  
DATA PACKAGE**

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley, CA 94710

-----  
ORGANIC ANALYTICAL REPORT

Work Order NO.: 4310

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical

Method: 418.1

Date Extracted: 09/22/92

QC Batch NO.: S92QCB023TPH

Date Analyzed: 09/22/92

-----  
Sample ID:                      Client ID:                      Result      Reporting      Percent  
   Limit      Moisture  
-----  
4310-01                      R2-V-7'3"                      9000                      4                      8.2  
4310-02                      R2-A-5-5.5'                      58                      5                      11.8  
4310-03                      R2-A-3-3.5'                      150                      4                      9.8  
MSTPH920922                      METHOD BLANK                      ND                      4                      NA  
-----

NA\_ Not Analyzed  
ND\_ Not Detected

ANALYST:

-----  


GROUP LEADER:

-----  


ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley. CA 94710

-----  
ORGANIC QUALITY CONTROL RESULTS SUMMARY  
Blank Spike/Spike Duplicate

Work Order NO.: 4310

QC Sample NO.: SSTPH920915A & B

Analytical Method: 418.1

Blank I.D.: MSTPH920915

Matrix: Soil

QC Batch NO.: S92QCB023TPH

Unit: mg/Kg

-----  
Parameter      Date  
                 Analyzed      BR      SA      BS      PR      BSD      PR      RPD  
-----  
TPH            09/22/92            0      165      176      107      172      104      2  
-----

BS-Blank Spike  
BSD-Blank Spike Duplicate  
SA-Spike Added  
BR\_Blank Result  
NA-Not Applicable  
NC-Not Calculated  
ND-Not Detected

$$RPD = ((BS - BSD) / ((BS + BSD) / 2)) * 100$$

$$PR = ((BS \text{ OR } BSD - BR) / SA) * 100$$

ANALYST:

-----  
*Alan J.*

QUALITY CONTROL:

-----  
*NWB*



**INORGANICS DATA PACKAGE**

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4310  
Matrix: SolidClient's ID: R2-V R2-A R2-A  
-7'3" -5-5.5' -3-3.5'Sample Date: 09/01/92 09/01/92 09/01/92  
% Moisture:  
Lab ID: 4310.01 4310.02 4310.03

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND ND ND	SM 403(M)	50	mg/Kg CaCO3	09/10/92
Moisture	8.2 11.8 9.8	ASTM D2216	.1	% by wt	09/18/92
pH	5.2 5.0 5.8	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable  
ND- Not DetectedANALYST: Don GleasonGROUP LEADER: Walter S. Lee

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4310  
Matrix: SolidClient's ID: Prep  
Blank

Sample Date:

% Moisture:

Lab ID: Prep Blank

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO3	09/10/92
Moisture	NA	ASTM D2216	.1	% by wt	09/18/92
pH	NA	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

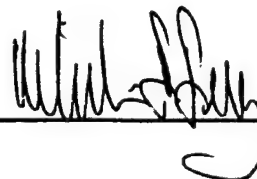
NA- Not Applicable

ND- Not Detected

ANALYST:



GROUP LEADER:



## INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order: 4310 % Moisture: NA  
Lab ID of LCS: Matrix: Solid  
Alkalinity: 452.22 LCS Units: mg/Kg CaCO3

Parameter	Date Analyzed LCS	LCS Result	Conc Added	% Rec LCS	Advisory Limits	
					-- % Rec -- Low	High
Alkalinity	09/10/92	23000.00	23650.00	97	80	120

ANALYST:

Don Gleator

Date

9/28/92

REVIEWER:

MB

Date

9/29/92

File:M1QCLCSW

## INORGANIC QC SUMMARY - MS and MSD

Work Order: 4310

% Moisture: NA

Alkalinity Moisture pH  
 Lab ID Spk/Dup: Blank Spk 4310.01 4294.01  
 QC Batch: 452.22 451.52 453.34

Matrix: Solid  
 Units: mg/Kg CaCO<sub>3</sub> (Alk)  
 % by wt. (Mois)  
 pH Units (pH)

Parameter	Date Analyzed MS/Dup	-----Results-----			RPD	RPD QC Limit	-Conc Added-		Percent Recovered	
		Unspiked Sample	MS/Sample	MSD/Dup			MS	MSD	MS	MSD
Alkalinity	09/10/92	0.00	23000.00	23000.00	0	20	23650.00	23650.00	97	97
Moisture	09/18/92		8.18	8.18	0	20				
pH	09/15/92		5.21	5.49	5	20				

\* or N = Outside QC Limit:

QC Limits for % Rec: 75 - 125

ANALYST:

*Don Pleator*

Date

*9/28/92*

REVIEWER:

*NWB*

Date

*9/29/92*

File: M1QCMSWH

**METALS DATA PACKAGE**

CLIENT SAMPLE ID

V-7'3"

Lab Code: ESBL Case No.: 4294S SAS No.: SDG No.: A-3

Level (low/med): LOW Date Sampled : 09/01/92

Solids: 91.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

CLIENT SAMPLE ID

A-5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

**Comments:**





CLIENT SAMPLE ID

PBLANK

## EPA SAMPLE NO.

## MPA-18L

Matrix (soil/water): SOIL\_ Level (low/med): LOW\_

[illegible]

## Method Detection Limits (Annually)

Lab Name: E\_S\_BERKELEY\_LABORATORY\_ Contract: AFCEE\_\_\_\_  
Lab Code: ESBL\_ Case No.: 4294S\_ SAS No.: \_\_\_\_\_ SDG No.: A-3\_\_\_\_  
ICP ID Number: TJA\_61\_\_\_\_M Date: 09/01/92  
Flame AA ID Number : \_\_\_\_\_ Matrix: SOIL\_  
Furnace AA ID Number : \_\_\_\_\_ (ug/L in 1.00g to 100ml digestate)

Analyte	Wave-length (nm)	Back-ground		MDL (ug/L)	M
Iron	271.44			47.0	P

Comments:

## PREPARATION LOG

Engineering Science - Berkeley Laboratory  
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E\_S\_BERKELEY\_LABORATORY\_

Contract: AFCEE\_\_\_\_\_

Lab Code: ESBL\_ Case No.: 4294S\_

SAS No.: \_\_\_\_\_ SDG No.: A-3\_

Instrument ID Number: TJA 61 M\_

Method: P\_

Start Date: 09/17/92

End Date: 09/17/92

EPA Sample No.	D/F	Time	% R	Analytes																	
				F																	
STD1	1.00	1423		X																	
STD2	1.00	1427		X																	
STD3	1.00	1432		X																	
STD4	1.00	1437		X																	
ICV	1.00	1441		X																	
ICB	1.00	1446		X																	
ICSA	1.00	1451		X																	
ICSAB	1.00	1455		X																	
CRI	1.00	1500																			
PBLANK	1.00	1504		X																	
ZZZZZZ	1.00	1509																			
LCSS	1.00	1514		X																	
LCSSD	1.00	1518		X																	
A-8.5'	1.00	1523		X																	
V-4.0'	1.00	1527		X																	
V-18'	1.00	1532		X																	
CCV	1.00	1537		X																	
CCB	1.00	1541		X																	
V-7'3"	1.00	1546		X																	
A-5	1.00	1551		X																	
A-3	1.00	1555		X																	
VW-8	1.00	1600		X																	
MPA-07	1.00	1604		X																	
MPA-18	1.00	1609		X																	
MPA-18S1	1.00	1614		X																	
MPA-18S2	1.00	1618		X																	
MPA-18L	1.00	1623		X																	
CCV	1.00	1627		X																	
CCB	1.00	1632		X																	
MPB-18	1.00	1637		X																	
MPB-06	1.00	1641		X																	
MPC-06	1.00	1646		X																	

## ANALYSIS RUN LOG

Contract: AFCEE\_\_\_\_\_

SAS No. : \_\_\_\_\_ SDG No. : A-3\_\_\_\_\_

Method: P\_

End Date: 09/17/92

ILMO2.1

**TOTAL KJELDAHL NITROGEN**  
**TOTAL PHOSPHATE**  
**SOIL CLASSIFICATION**  
**DATA PACKAGE**





# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310  
Sample Descript: Soil  
Analysis for: Total Phosphorous  
First Sample #: 209-0841

Sep. TP 9/28/92  
Sampled: Aug 1, 1992  
Received: Sep 8, 1992  
Analyzed: Sep 16, 1992  
Reported: Sep 22, 1992

## LABORATORY ANALYSIS FOR: Total Phosphorous

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0841	R2-V-7'-3"	10	43
209-0842	R2-A-5'-5.5'	10	81
209-0843	R2-A-3'-3.5'	10	110
-	Method Blank	10	N.D.

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

 10/14  
ESBL PROJECT MANAGER DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

Please Note:

Analysis results reported on a dry-weight basis.

2090841.ENG <4>



# SEQUOIA ANALYTICAL

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Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310  
Sample Descript: Soil  
Analysis for: Total Kjeldahl Nitrogen  
First Sample #: 209-0841

Sampled: ~~Aug~~ 1, 1992  
Received: Sep 8, 1992  
Analyzed: Sep 16, 1992  
Reported: Sep 22, 1992

TP 9/28/92

## LABORATORY ANALYSIS FOR: Total Kjeldahl Nitrogen

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0841	R2-V-7'-3"	20	37
209-0842	R2-A-5'-5.5'	20	31
209-0843	R2-A-3'-3.5'	20	70
-	Method Blank	20	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

Please Note:

Analysis results reported on a dry-weight basis.

2090841.ENG <5>



# SEQUOIA ANALYTICAL

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Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310

QC Sample Group: 209-0841-43

Revised: Sep 28, 1992

## QUALITY CONTROL DATA REPORT

ANALYTE	Total Phosphorous	Total Kjeldahl Nitrogen

Method:	EPA365.3	EPA351.4
Analyst:	K. Follett	G. Kern
Reporting Units:	mg/kg	mg/kg
Date Analyzed:	Jul 16, 1992	Sep 16, 1992
QC Sample #:	209-0841	209-0843

Sample Conc.:	43	70
---------------	----	----

Spike Conc. Added:	110	4300
--------------------	-----	------

Conc. Matrix Spike:	130	3900
---------------------	-----	------

Matrix Spike % Recovery:	79	89
--------------------------	----	----

Conc. Matrix Spike Dup.:	140	4100
--------------------------	-----	------

Matrix Spike Duplicate % Recovery:	88	94
------------------------------------	----	----

Relative % Difference:	7.4	5.0
------------------------	-----	-----

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

% Recovery:	$\frac{\text{Conc. of M.S.} - \text{Conc. of Sample}}{\text{Spike Conc. Added}} \times 100$
Relative % Difference:	$\frac{\text{Conc. of M.S.} - \text{Conc. of M.S.D.}}{(\text{Conc. of M.S.} + \text{Conc. of M.S.D.}) / 2} \times 100$

2090841.ENG <6>



# SEQUOIA ANALYTICAL

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Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310  
Sample Descript: Soil, R2-V-7-3"  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0841

Sampled: Aug 1, 1992  
Received: Sep 8, 1992  
Analyzed: Sep 15, 1992  
Reported: Sep 22, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:  
(B) WEIGHT RETAINED IN NO. 10 SIEVE:  
(C) % PASSING NO. 10 SIEVE:

211.94g
2.99g
98.59%

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	0.35	0.17	0.17	99.83
No. 10	2.64	1.25	1.42	98.58
PAN	0.0			
TOTAL	2.99			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	21	21	17	13.5	0.035	26
5	21	20	16	13.7	0.022	24
10	21	19	15	13.8	0.016	23
15	21	18	14	14.0	0.013	21
25	21	18	14	14.0	0.010	21
40	21	17	13	14.2	0.0080	20
60	21	17	13	14.2	0.0066	20
90	21	16	12	14.3	0.0054	18
120	21	15	11	14.5	0.0047	17
1440	21	12	8	15.0	0.0014	12

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
SPECIFIC GRAVITY (ASSUMED):  
DISPERSING AGENT CORRECTION FACTOR (E):  
MENISCUS CORRECTION FACTOR (F):  
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.994
2.65
3
1
0.01348

FORMULAS:  
 $R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

SEQUOIA ANALYTICAL

  
 Tod Granicher  
 Project Manager



# SEQUOIA ANALYTICAL

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Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310  
Sample Descript: Soil, R2-A-5'-5.5'  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0842

Sampled: Aug 1, 1992  
Received: Sep 8, 1992  
Analyzed: Sep 15, 1992  
Reported: Sep 22, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:  
(B) WEIGHT RETAINED IN NO. 10 SIEVE:  
(C) % PASSING NO. 10 SIEVE:

222.32g
4.03g
98.19%

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½in.	0.0	0.0	0.0	100
3/8in.	0.0	0.0	0.0	100
No. 4	0.18	0.08	0.08	99.92
No. 10	3.85	1.73	1.81	98.19
PAN	0.0			
TOTAL	4.03			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	20	28	24	12.4	0.034	37
5	20	27	23	12.5	0.022	35
10	20	26	22	12.7	0.015	34
15	20	25	21	12.9	0.013	32
25	20	25	21	12.9	0.010	32
40	20	24	20	13.0	0.0078	30
60	20	24	20	13.0	0.0064	30
90	20	24	20	13.0	0.0052	30
120	20	23	19	13.2	0.0045	29
1440	20	20	16	13.7	0.0013	24

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
SPECIFIC GRAVITY (ASSUMED):  
DISPERSING AGENT CORRECTION FACTOR (E):  
MENISCUS CORRECTION FACTOR (F):  
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.992
2.65
3
1
0.01365

### FORMULAS:

$R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

SEQUOIA ANALYTICAL

  
Tod Granicher  
Project Manager

2090841.ENG <2>



# SEQUOIA ANALYTICAL

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(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: W.O. #4310  
Sample Descript: Soil, R2-A-3'-3.5'  
Method of Analysis: ASTM D422-63  
Lab Number: 209-0843

Sampled: Aug 1, 1992  
Received: Sep 8, 1992  
Analyzed: Sep 15, 1992  
Reported: Sep 21, 1992

## PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

### SIEVE TEST

- (A) TOTAL WEIGHT OF SAMPLE:  
(B) WEIGHT RETAINED IN NO. 10 SIEVE:  
(C) % PASSING NO. 10 SIEVE:

205.99g
19.88g
90.35%

SIEVE TEST FOR  
WEIGHT RETAINED  
IN NO. 10 SIEVE

IDEAL PAN = 0.0  
IDEAL TOTAL = (B)

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in.	0.0	0.0	0.0	100
3/8 in.	2.80	1.36	1.36	98.64
No. 4	4.91	2.38	3.74	96.26
No. 10	12.17	5.91	9.65	90.35
PAN	0.0			
TOTAL	19.88			

### HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	20	24	20	13.0	0.035
5	20	23	19	13.2	0.022
10	20	22	18	13.3	0.016
15	20	22	18	13.3	0.013
25	20	22	18	13.3	0.010
40	20	21	17	13.5	0.0079
60	20	20	16	13.7	0.0065
90	20	20	16	13.7	0.0053
120	20	19	15	13.8	0.0046
1440	20	18	14	14.0	0.0013

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):  
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):  
SPECIFIC GRAVITY (ASSUMED):  
DISPERSING AGENT CORRECTION FACTOR (E):  
MENISCUS CORRECTION FACTOR (F):  
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):

65g
0.990
2.65
3
1
0.01365

#### FORMULAS:

$R = H - E - F$   
 $S = K [ \text{SQRT} (L / T) ]$   
 $P = (R / W) 100$   
 $W = (J \cdot 100) / C$   
 $J = D \cdot G$

SEQUOIA ANALYTICAL

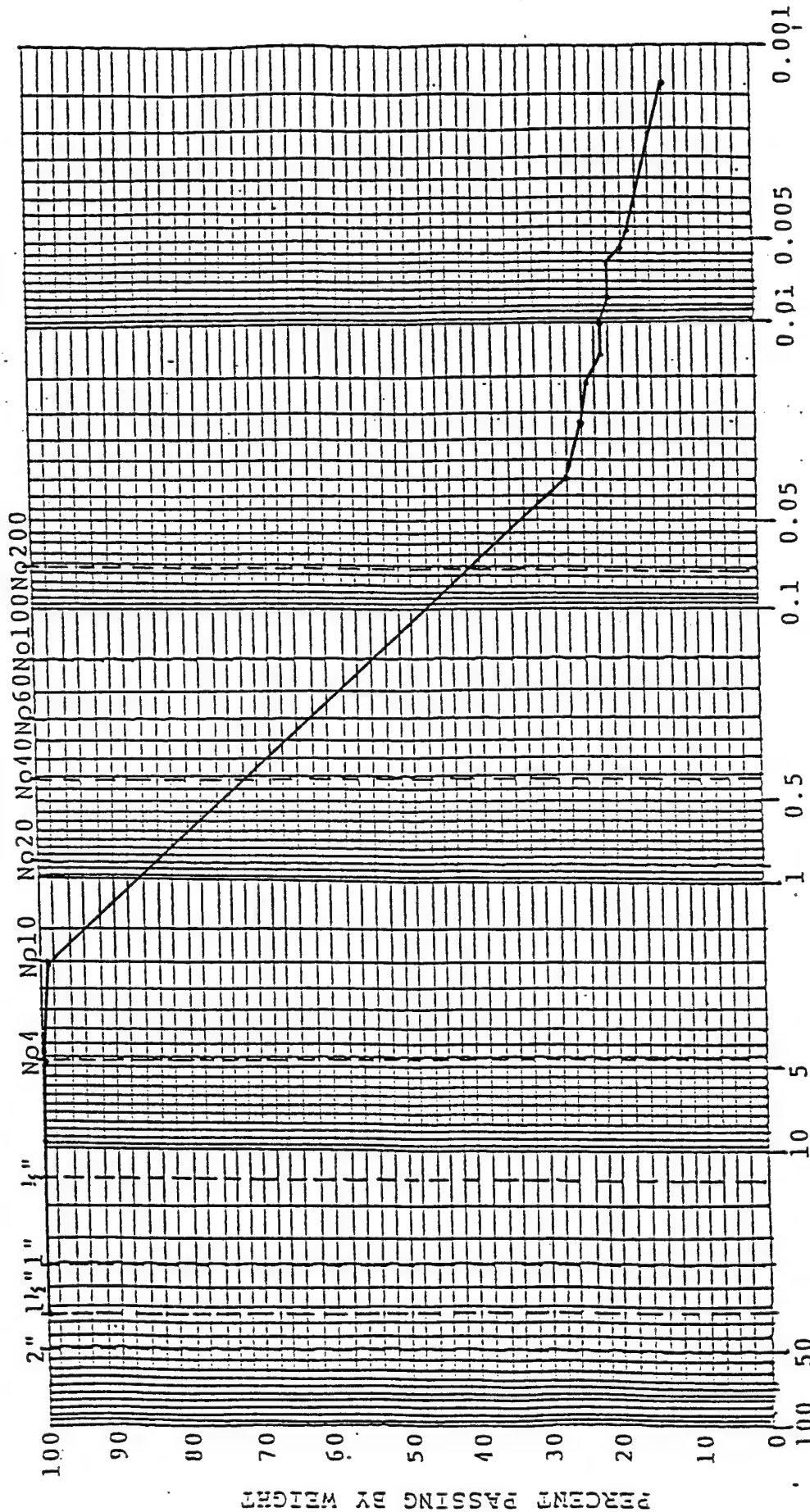
Tod Granicher  
Project Manager

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0841

U.S. STANDARD SIEVE SIZES

GRAVEL		U.S.
SAND		
SILT		25%
CLAY		14%



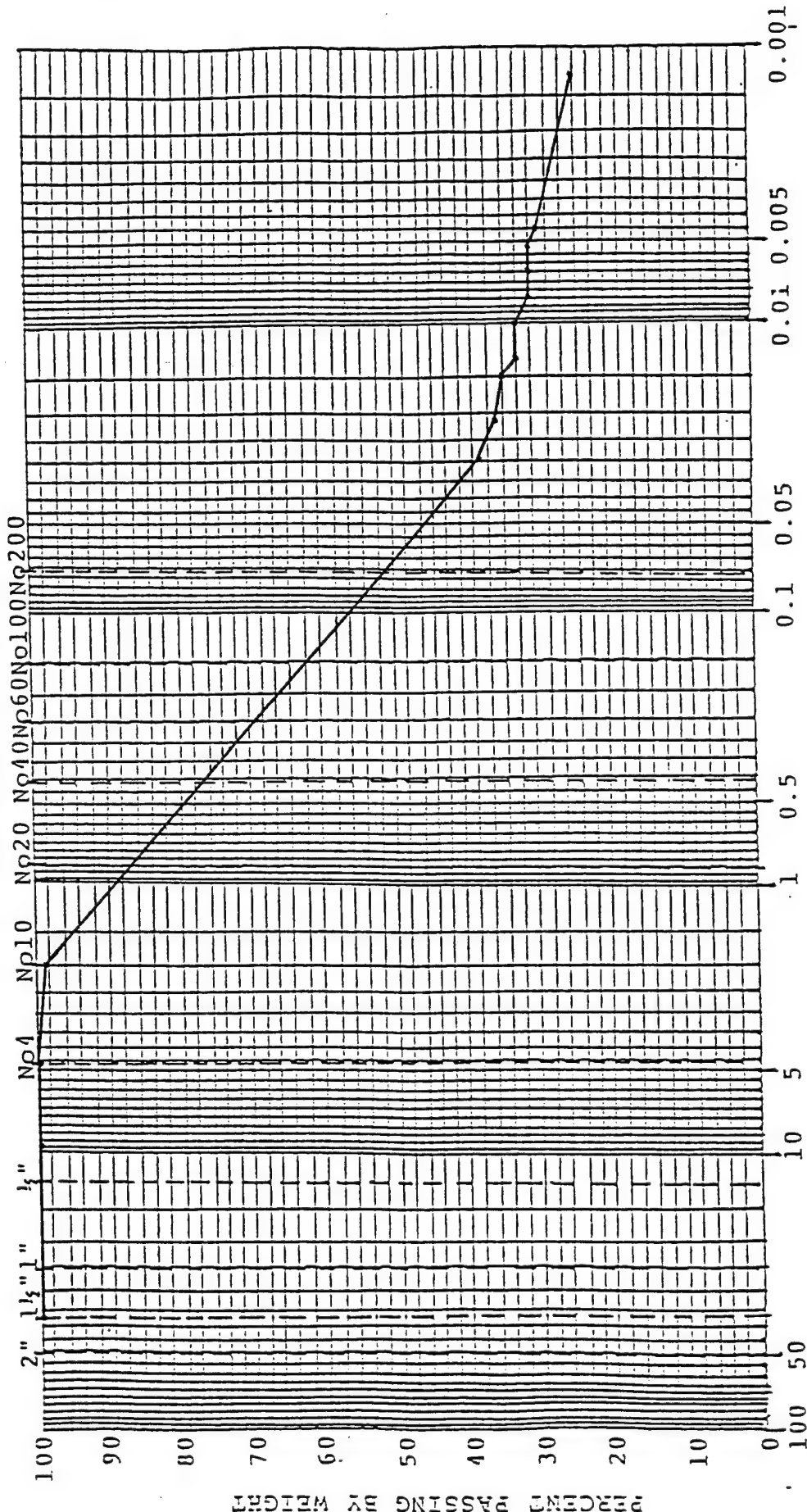


SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0842

U.S. STANDARD SIEVE SIZES

GRAVEL	
SAND	49%
SILT	25%
CLAY	26%



GRAIN DIAMETER IN MILLIMETERS

COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
GRAVEL		SAND			FINES	
BOBBLES						

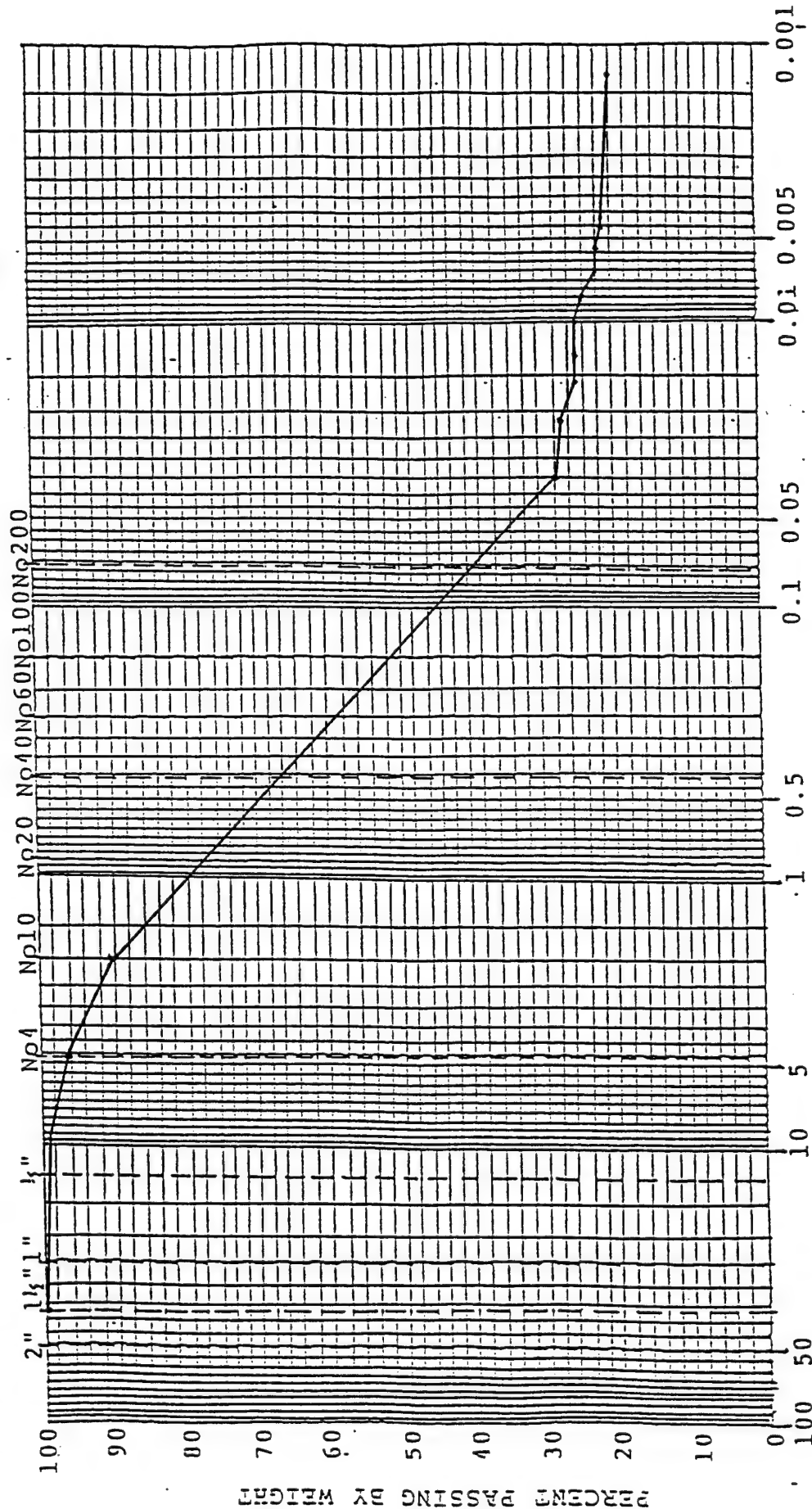
OBDDBS



SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0843

U.S. STANDARD SIEVE SIZES



GRAIN DIAMETER IN MILLIMETERS

COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
GRAVEL		SAND			FINES	

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

ES JOB NO.		PROJECT NAME/LOCATION		PRESERVATIVES REQUIRED										ANALYSES REQUIRED										SHIP TO:					
		4310																											
FIELD CONTACT:																													
SAMPLERS NAMES & SIGNATURES																													
<i>Estelito Delos Trinos</i> ESTELITO DELOS TRINOS																													
DATE	TIME	FIELD SAMPLE IDENTIFIER	TKN	10% PHOSPHATE	ASTM D422 Sieve Hydrom.																					REMARKS			
8/1/92	1300	R2-V-7'3" (4310.01C)	/	/	/																					TKN 351.2			
8/1/92	1500	R2-A-5-5.5' (4310.02C)	/	/	/																					Phosphorus 365.3			
8/1/92	1445	R2-A-3-3.5' (4310.03C)	/	/	/																					2 wk TAT			
																										Report to: Tom Paulson			
																										ESBL			
																										Report results in dry soil basis.			
FIELD CUSTODY RELINQUISHED BY:				DATE: 9/18/92 TIME: 1125																									
SHIPPED VIA:		AIRBILL #		ON RECEIPT: CUSTODY SEALS? _____ ; TEMP: _____ °C																									
RECEIVED FOR LABORATORY BY:				DATE: 9/18/92 TIME: 11:25 AM																									

read by: K Guevedo 9-8-92



**Battelle**

Columbus Laboratories

Proj. No.

DE268.03

Project Title

RAFB / Battelle

SAMPLERS: (Signature)

*Armando Bush*

DATE

TIME

SAMPLE I.D.

01 Sept 92 1300

R2-V-7'3"

01 Sept 92 1300

R2-V-7'3"

01 Sept 92 1300

R2-V-7'3"

01 Sept 92 1500

R2-A-5-5.5'

01 Sept 92 1500

R2-A-5-5.5'

01 Sept 92 1500

R2-A-5-5.5'

01 Sept 92 1445

R2-A-3-3.5'

01 Sept 92 1445

R2-A-3-3.5'

01 Sept 92 1445

R2-A-3-3.5'

SAMPLE TYPE (V)

PH  
alkalinity  
IRON  
TOTAL HOUSURE  
TOTAL KJELDAHL  
TOTAL NITROGEN  
TOTAL phosphate  
Sieve analysis

Container No.

Number of Containers

Remarks

Brass Sleeve  
4oz Glasses  
16oz Glasses  
Brass Sleeve  
4oz glasses  
16oz Glasses  
Brass Sleeve  
4oz glasses  
16oz glasses

Relinquished by: (Signature)

*Armando Bush*

Date/Time

9-3-92 1310

Received by: (Signature)

*Paul J. J.*

Relinquished by: (Signature)

Received by: (Signature)

Date/Time

Received by: (Signature)

Relinquished by: (Signature)

Date/Time

Received by: (Signature)

Relinquished by: (Signature)

Date/Time

Received by: (Signature)

Relinquished by: (Signature)

Date/Time

Received for Laboratory by: (Signature)

*Armando Bush*

Remarks

Date/Time

9/3/92 1310

Form No.

CHAIN OF CUSTODY RECORD

**APPENDIX E**  
**SITE SS-10 SOIL GAS PERMEABILITY DATA**

TABLE E-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPA

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	6'	4.5'	3'		6'	4.5'	3'
0	0.005	0.005	0	18	18.0	17.9	0.015
1	17.5	17	0.015	21	18.1	18.0	0.015
2	17.6	17.5	0.015	24	18.0	17.9	0.015
3	17.7	17.8	0.015	27	18.1	17.9	0.015
4	18	17.9	0.015	30	18.2	17.9	0.015
5	18.5	17.9	0.015	35	18.2	17.9	0.015
6	18.5	17.5	0.015	40	18.2	17.9	0.015
7	18.5	17.5	0.015	45	18.2	18.0	0.015
8	18.0	17.5	0.15	55	18.2	18.1	0.015
9	17.9	17.6	0.010	65	18.3	18.0	0.015
10	17.9	17.6	0.010	75	18.5	18.0	0.015
11	17.9	17.5	0.010	95	18.5	18.0	0.015
12	17.9	17.5	0.010	115	18.5	18.0	0.015
15	17.9	17.5	0.010	135	18.5	18.0	0.015

**TABLE E-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPB**

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	3'	4'5"	9'		3'	4'5"	9'
0	0	0.015	0.02	15	0.05	6.0	6.5
1	0.02	3.7	4.5	17	0.054	6.0	6.5
2	—	—	—	20	0.054	6.0	6.5
3	0.042	5.6	6.2	25	0.066	6.4	6.6
4	—	—	—	30	0.055	6.3	6.7
5	0.047	6.0	6.4	40	0.055	6.4	6.9
6	—	—	—	50	0.06	6.5	7.0
7	0.052	6.0	6.4	60	0.057	6.6	7.2
8	—	—	—	80	0.049	6.7	7.4
9	0.050	5.9	6.3	100	0.047	6.8	7.5
10	—	—	—	120	0.044	7.0	7.6
11	0.05	5.9	6.3	140	0.047	7.0	7.7
13	0.05	6.0	6.4				

TABLE E-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPC

Time (min)	Pressure (psi) at Depth			Time (min)	Pressure (psi) at Depth		
	3'	4'5"	6'		3'	4'5"	6'
0	0	0	0	13	0	0.225	0.22
1	<0	0.02	0.04	15	0	0.27	0.245
2	—	—	—	17	0	0.29	0.270
3	0	0.03	0.06	20	0	0.37	0.32
4	—	—	—	25	0	0.23	0.27
5	0	0.1	0.125	30	0	0.27	0.23
6	—	—	—	40	0	0.22	0.205
7	0	0.065	0.085	50	0	0.27	0.25
8	—	—	—	60	0	0.23	0.22
9	0.02	0.045	0.07	80	0	0.23	0.222
10	—	—	—	100	0	0.235	0.215
11	0	0.205	0.19				

**APPENDIX F**

**SITE SS-10 IN SITU RESPIRATION TEST DATA**



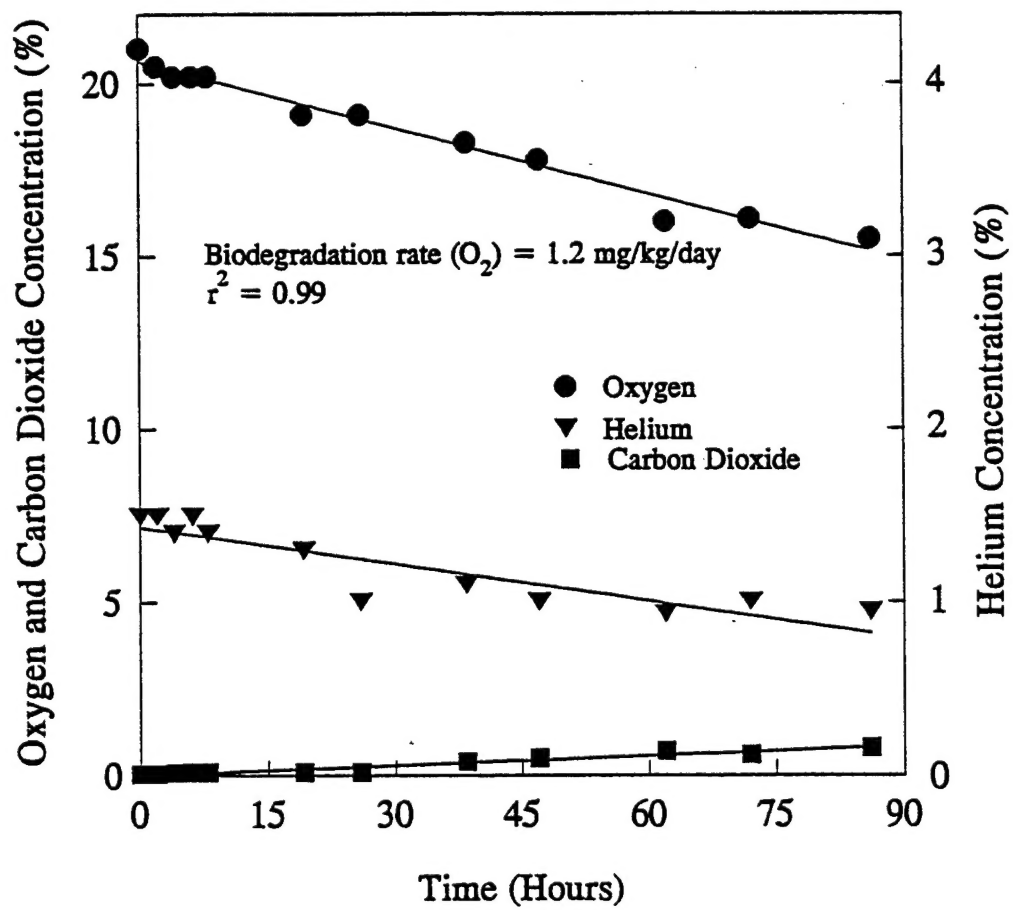


Figure F-1. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R2-MPA-4'6"

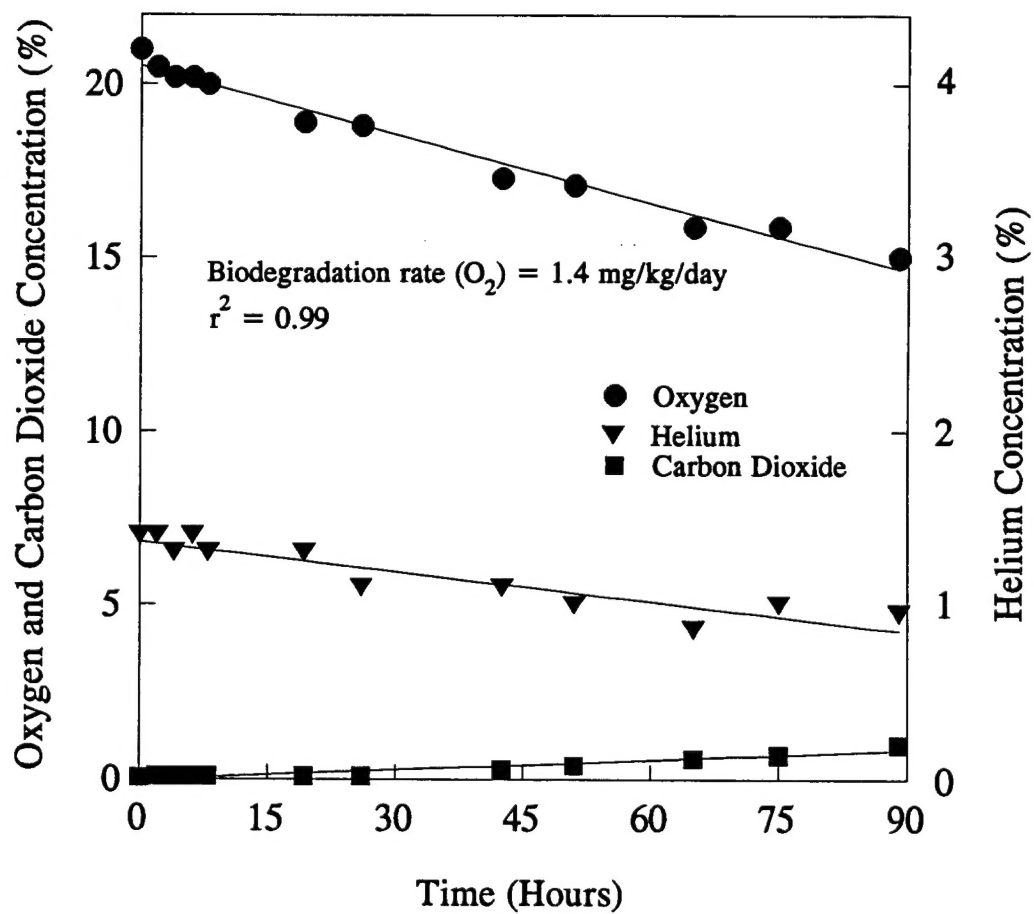


Figure F-2. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R2-MPA-6'

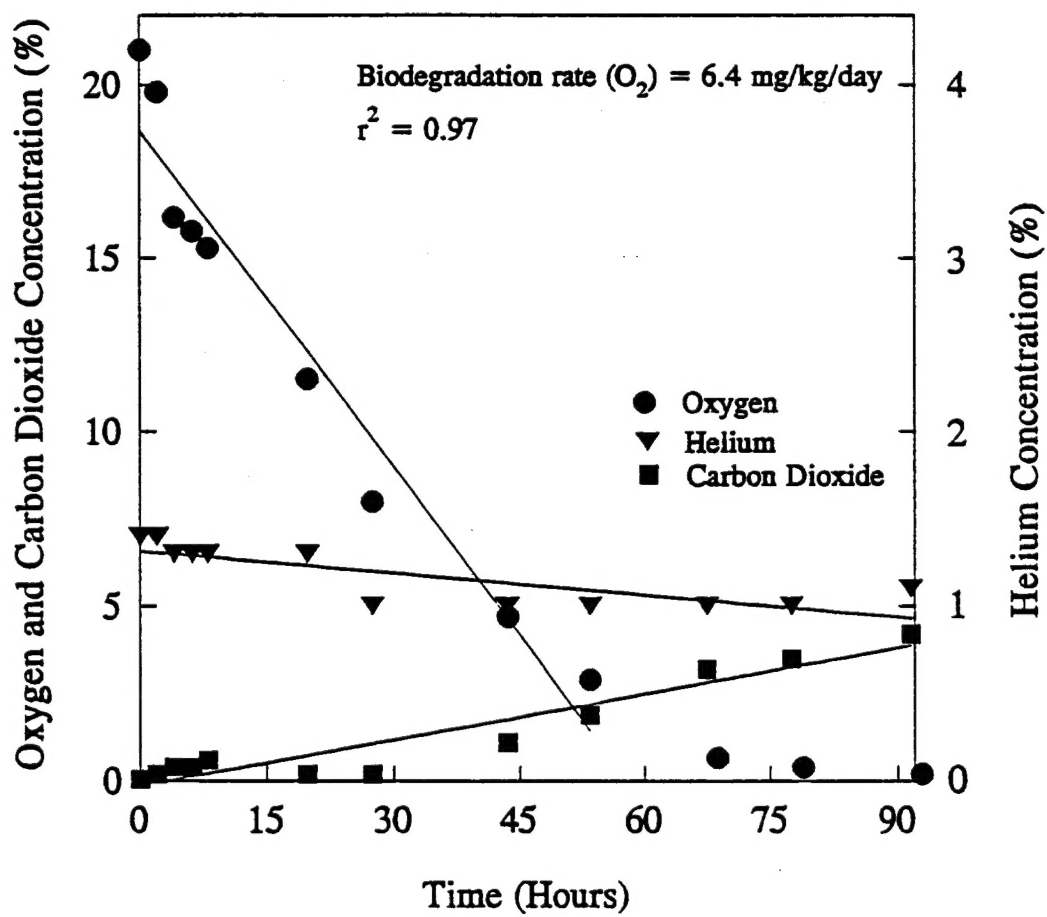


Figure F-3. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R2-MPC-4'6"

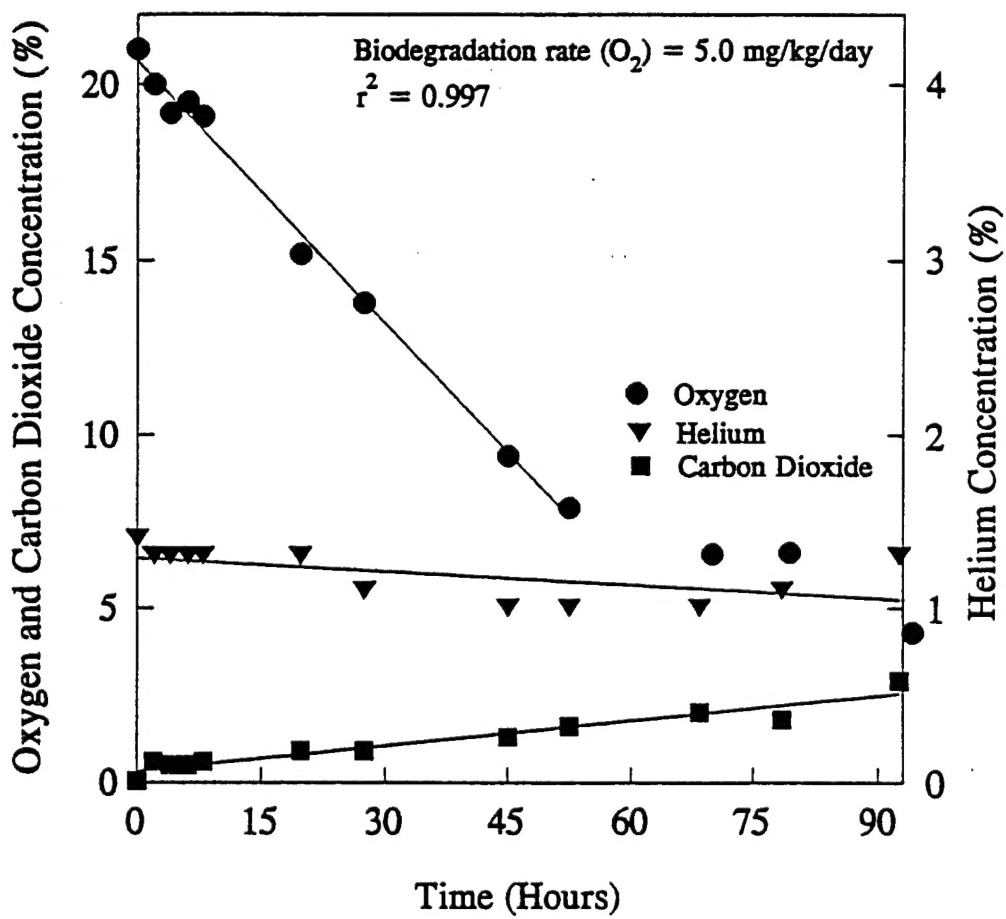


Figure F-4. Oxygen Utilization and Carbon Dioxide Production During In Situ Respiration Test at Monitoring Point R2-MPC-6'